

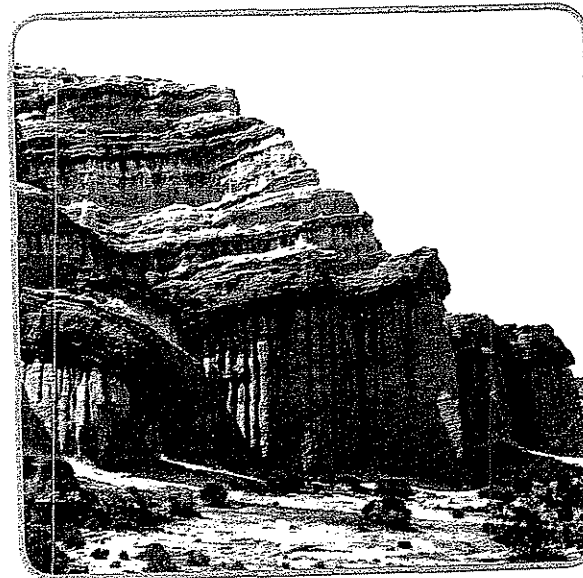
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Earth Science Workshop 1



UNDERSTANDING the EARTH'S SURFACE

SEYMOUR ROSEN



Globe Book Company, Inc.
Englewood Cliffs, New Jersey

THE AUTHOR

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BEFORE YOU BEGIN . . .

Earthquakes, volcanoes, and quiet streams—what do they have in common? They all affect the world we live on. Each day the shape of the earth is changed. In this book, you will learn how some of these changes are made.

Oil, water, diamonds, and gold are some of the things we take from the earth. Each day somewhere people dig and drill to get these things. In this book you will learn about the valuable things that come from the earth. You will learn important facts about the earth that influence all of our lives.

Your book is set up a special way to help you learn about the earth you live on. Each Aim begins with the things you'll need to know. This is followed by a series of exercises. Take your time on these. And look back to the Aim page when you're not sure of an answer. There will be experiments along the way—and a few surprises, too!

Remember, the earth is changing even as you read this page. Now you can begin to find out how!

Science is the study of the world around you. The study of any branch of science includes "learning by doing." Investigations, experiments, demonstrations. Activities in which you are involved. You make things happen.

Safety is a very important part of these activities. Even if you are only reading about an investigation, you should know about the safety precautions that **MUST** be taken. The following **SAFETY ALERT SYMBOLS** are designed to call these precautions to your attention. They appear on pages wherever any of these dangers are present.



Safety Goggles



Lab Apron
or Coat

Safety goggles and a laboratory apron or coat should be worn for all activities or investigations.



Open Flame

When working near an open flame, be sure that hair and loose clothing are secured in some manner.



Poison

Many chemicals are poisonous, or toxic. *Never* taste, touch, or smell any unknown substance unless told to do so by your teacher.



Caustic Substances

Caustic (KAW stik) substances can burn your skin, eyes, and clothing. Handle these substances with extreme care. Acids and bases (such as lye) are caustic.



Toxic Vapors

Never inhale any vapors directly. To test the odor of a substance, use your hand to waft the vapors to your nose.



Sharp Objects

Always handle sharp objects with great care.



Broken Glass

Glassware, such as beakers, test tubes, glass tubing, and thermometers should be handled very carefully to avoid breakage. *Never* pick up broken glass with your bare hands.



Electric Shock

Never use electrical appliances near water or other liquids. Always inspect wiring for worn or broken insulation. Unplug all electric cords when not in use.

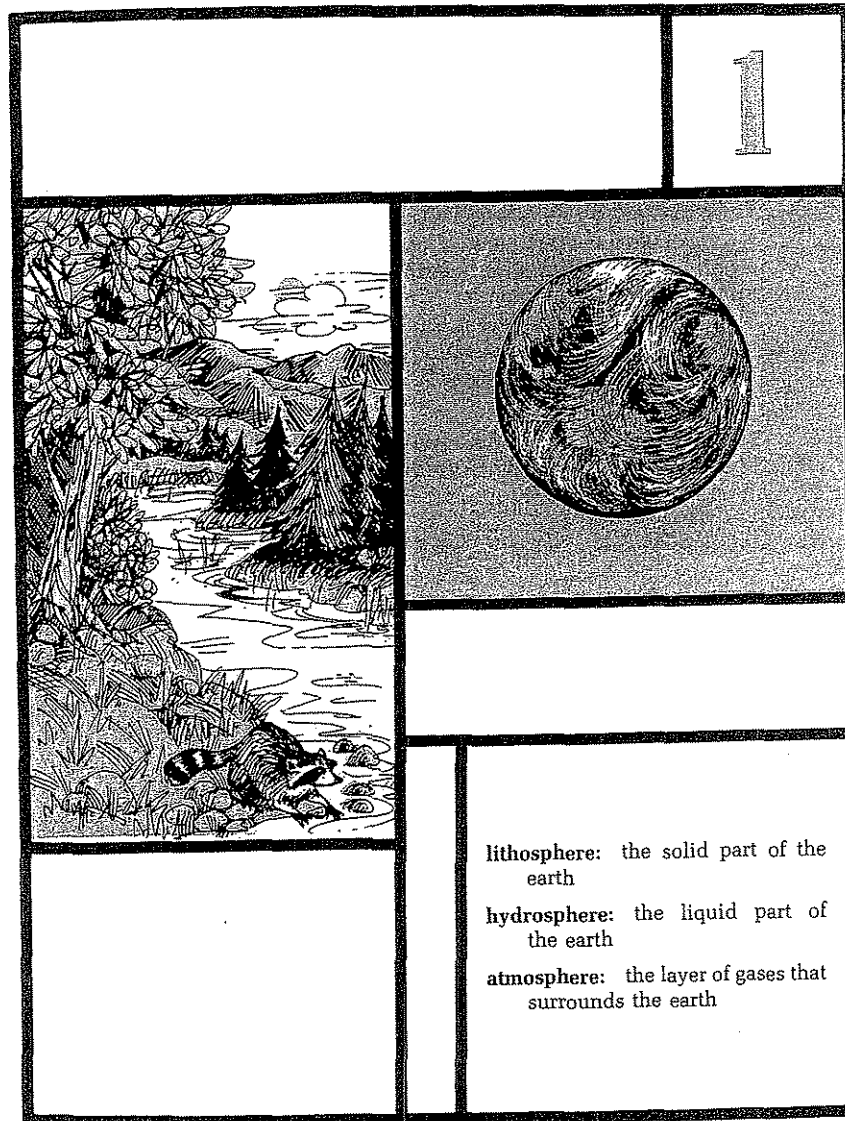


Hot Objects

When handling hot objects, use tongs or padded gloves. *Never* set hot objects directly on a desk or table top. Set them on a heat-resistant pad.

WHAT ARE THE PARTS OF OUR EARTH?

1



lithosphere: the solid part of the earth

hydrosphere: the liquid part of the earth

atmosphere: the layer of gases that surrounds the earth

AIM | What are the parts of our 1 | earth?

Nine planets circle around our sun. We live on one of those planets—Earth. We are used to our planet. We don't often think about what it is like.

People have wondered about the other planets and about our moon. Wondering finally led to action. In 1969, astronauts brought back the first samples of rocks and soil from the moon. They also learned that there is no water and no air on the moon. Spaceships have begun to explore Mars and the other planets. Some day we shall know whether these planets have air and water and life.

Our planet, Earth, has water, and it has air. Earth has rocks and soil. Scientists have divided our planet into three parts—a solid part, a liquid part, and a part made of gases.

SOLID The solid part is called the *lithosphere* [LITH us fear]. The lithosphere is made of rocks, minerals, and soil.

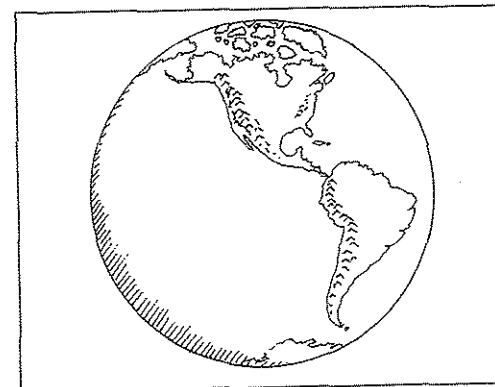
LIQUID The liquid part of Earth is called the *hydrosphere* [HIDE rus fear]. The hydrosphere covers about three-quarters of our planet. The hydrosphere is mostly water.

GAS The layer of gases around Earth is called the *atmosphere* [AT mus fear]. Two important gases in the atmosphere are oxygen (OX uh jen) and carbon dioxide [KAR bin die OX side].

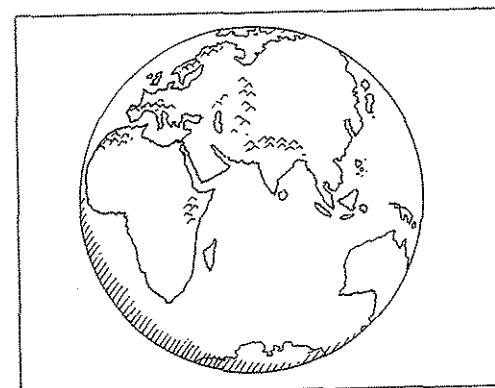
Living things need all three parts of our planet. Plants need soil and minerals. Animals need plants. All living things need water and oxygen. Plants need carbon dioxide too. Scientists believe that life started in water.

OUR PLANET EARTH

One side looks like this.



The other side looks like this.



- I. Do the following:
 1. Fill in the lithosphere with pencil.
 2. Fill in the hydrosphere with a blue pencil, pen, or crayon.
- II. Circle the letter of the correct answer to this question.
 3. Look at the atmosphere on the diagram. The shading gets lighter as you go higher because
 - a) the higher you go, the less air there is.
 - b) the higher you go, the more air there is.

COMPLETING SENTENCES

Complete the sentences with the choices below. Two of these may be used twice.

carbon dioxide
hydrosphere
water
sun

nine
lithosphere
oxygen

atmosphere
planet
soil

1. Earth is a _____.
2. The planets move around the _____.
3. _____ planets move around our sun.
4. The solid part of the earth's surface is called the _____.
5. The gases that surround our planet make up the _____.
6. The layer of water that covers three-fourths of the earth is called the _____.
7. The part of lithosphere that plants need is _____.
8. Two important gases of the atmosphere are _____ and _____.
9. Both animals and plants need the gas _____. Plants also need the gas _____.
10. Scientists believe that all life started in _____.

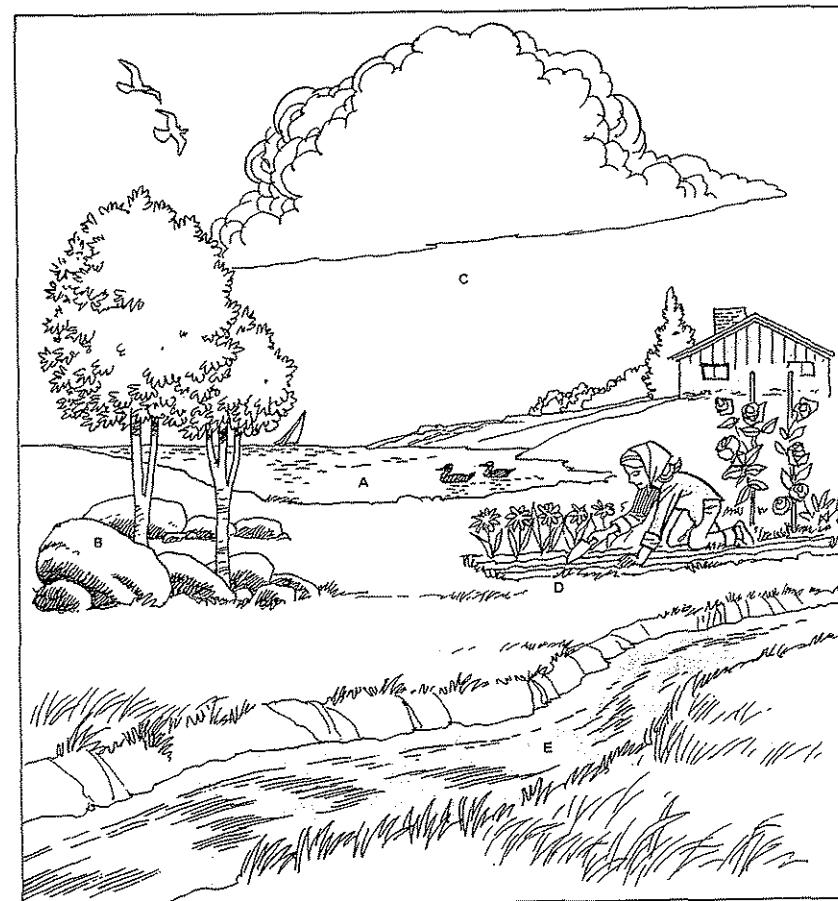
MATCHING

Match the two lists. Write the correct letter on the line next to each number.

- | | |
|---------------------------|--------------------------------|
| 1. _____ water planet | a) needed by all living things |
| 2. _____ atmosphere | b) water layer |
| 3. _____ hydrosphere | c) rocks, minerals, and soil |
| 4. _____ lithosphere | d) Earth |
| 5. _____ water and oxygen | e) mixture of gases |

NAME THE "SPHERES"

Each part of the diagram below belongs to either the atmosphere, hydrosphere, or lithosphere. To which "sphere" does it belong? Write your answer on the blank space.

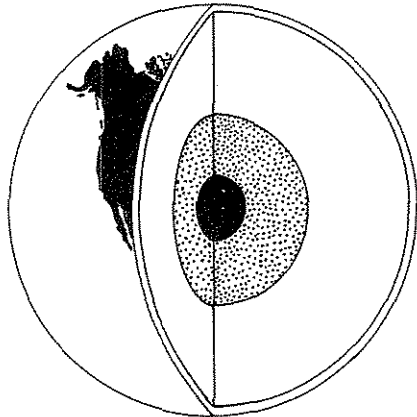
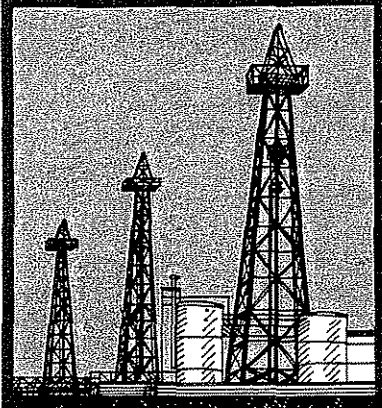


1. A is part of which "sphere"? _____
2. B is part of the _____
3. C is part of the _____
4. D is part of the _____
5. E is part of the _____

TRUE OR FALSE Write T on the line next to the number if the sentence is true.
Write F if the sentence is false.

1. _____ Most of our planet is covered with rocks.
2. _____ The lithosphere is a mixture of gases.
3. _____ Soil is part of the lithosphere.
4. _____ Oxygen is part of the atmosphere.
5. _____ Living things need water and oxygen.
6. _____ We know more about Mars than about Earth.
7. _____ The moon has air and water.
8. _____ The hydrosphere is wet.
9. _____ Scientists believe that life started in the hydrosphere.
10. _____ Only animals need oxygen.

WHAT IS INSIDE THE EARTH?

		2
		
		crust: the outside layer of the earth mantle: the layer of the earth just below the crust core: the center part of anything

AIM | What is inside the earth?

2

If you could dig a hole all the way to the center of the earth, what would you see? Would the earth look the same all the way through?

Scientists have wondered about the inside of our earth. They have found ways to study it. They use special tools to dig out samples from deep inside. Special instruments "look into" parts of the earth we cannot see.

The scientists have learned that the earth is not the same all the way through. Temperature becomes greater the deeper you go. Pressure becomes greater.

The earth has four different layers. They are the crust, mantle, outer core, and inner core. Each is made of different materials.

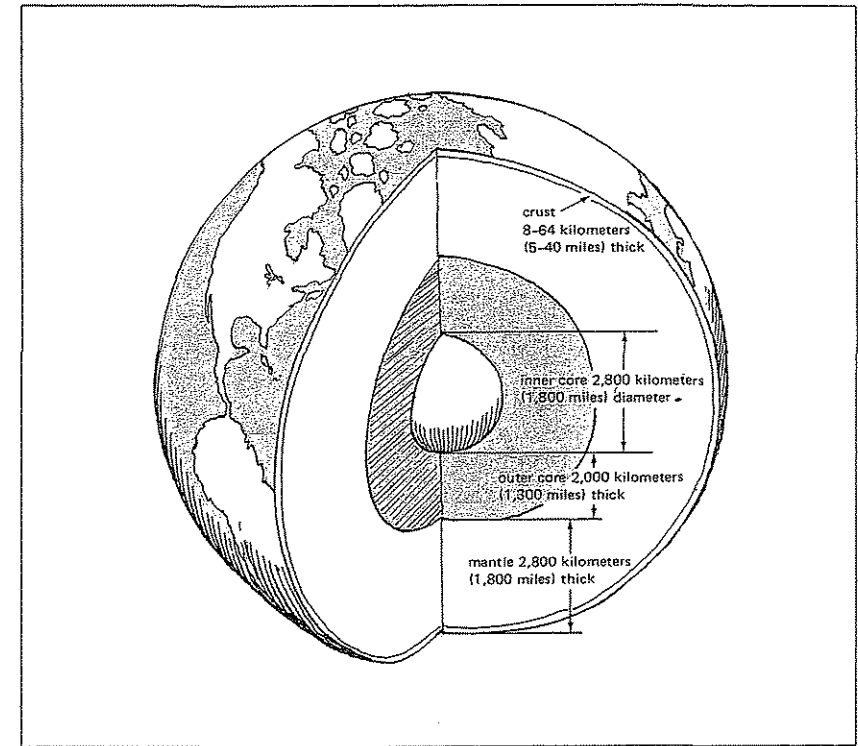
CRUST The outside layer is the crust. The crust is from 8 to 64 kilometers (5 to 40 miles) thick. It is thicker in some places and thinner in others. It is made of loose rocks and soil. Under the rocks and soil, the crust is solid rock. We live on the crust.

MANTLE The layer below the crust is the mantle. It is about 2,800 kilometers (1,800 miles) thick. It is solid rock. Mantle rock is heavier than crust rock.

OUTER CORE Just under the mantle is the outer core. The outer core is about 2,000 kilometers (1,300 miles) thick. It contains melted iron and nickel.

INNER CORE The inner core is the center of the earth. It is about 2,800 kilometers (1,800 miles) at its thickest. The inner core is solid—not liquid, as many people think—iron and nickel.

THE EARTH'S LAYERS



1. Which layers are the thickest? _____
2. Which layer is the thinnest? _____
3. On which layer do we live? _____
4. Which layer is the hottest? _____
5. Which layer is the coolest? _____
6. Which layer touches the atmosphere? _____
7. Which layer has melted material? _____
8. What is the center layer called? _____
9. Name the layer between the crust and the outer core. _____
10. Name the layer between the inner core and the mantle. _____

COMPLETING SENTENCES

Complete the sentences with the choices below. Three of these may be used more than once.

mantle crust inner core
outer core

- Starting with the top layer, the four layers of the earth are the _____, the _____, the _____ and the _____.
- The layer that has melted iron and nickel is the _____.
- The lightest weight rocks are found in the _____.
- The layer that has the highest temperature is the _____.
- The layer that has the lowest temperature is the _____.

TRUE OR FALSE

Write T on the line next to the number if the sentence is true.
Write F if the sentence is false.

- _____ Every layer of the earth is the same thickness.
- _____ The crust has the lightest weight rocks.
- _____ The mantle contains soil.
- _____ The mantle is the thickest layer.
- _____ We live on the crust.
- _____ The deeper we go into the earth, the cooler it becomes.
- _____ Most of our planet is made of soil.
- _____ The lower part of the atmosphere touches the crust.
- _____ Pressure is greatest in the inner core.
- _____ The crust is the coolest layer of the earth.

MATCHING

Match the two lists. Write the correct letter on the line next to each number.

- | | |
|---------------------|------------------------------------|
| 1. _____ mantle | a) we live on this layer |
| 2. _____ crust | b) layer below the crust |
| 3. _____ inner core | c) contains melted iron and nickel |
| 4. _____ outer core | d) layer of air |
| 5. _____ atmosphere | e) contains solid iron and nickel |

WORD SCRAMBLE

Unscramble each of the following to form a word or term that you have read in this Aim.

- TELNAM _____
- STRUC _____
- KILNEC _____
- SEPREURS _____
- LOSI _____

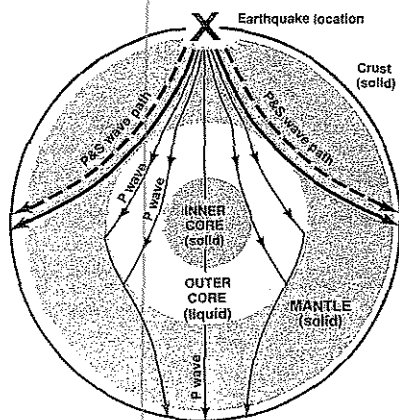
REACHING OUT

Scientists believe that our planet was once all melted material. When it cooled, the different materials separated into layers.

How would this explain the fact that the lightest weight rocks are found in the crust?

Hint: Throw a penny and a piece of wood into a bowl of water. Watch what happens and think about it.

KEEPING UP WITH SCIENCE



"LOOKING" INTO THE EARTH

We know a great deal about the surface of the earth. Most of this knowledge is direct knowledge. This means that scientists can see and touch the rocks to study them.

But how do we learn about the earth's interior? The deepest mine is less than 1.86 miles (3 kilometers) deep. The deepest boreholes for oil are only several miles deeper. These are hardly pinpoints compared to the size of the earth.

We learn about the inside of the earth by indirect means. That means, we do not actually see or touch the rocks. Scientists draw conclusions by analyzing information recorded by instruments. The most important is the information made during earthquakes. The instruments that record earthquakes are called seismographs.

Thousands of earthquakes occur each year. Earthquake stations throughout the world record the vibrations they cause. During an earthquake the needle of a seismograph records the vibrations of the earth's crust. This is done on a long roll of paper. This record is called a seismogram.

Earthquakes produce three kinds of waves, or vibrations. Two of them, the primary (P) wave and the secondary (S) wave penetrate deep into the earth. P waves travel through both solids and liquids. S waves travel only through solids. They do not penetrate liquids or a soft plastic state.

If the earth were solid all the way through, both the P and S waves would pass through every part of it. Earthquake waves would be recorded at seismograph stations at the opposite side of the earth from the quake. However, seismograms show that only the P waves pass through every part of the earth. The S waves do not. S waves turn away at areas deep inside the earth. This fact indicates that at those areas, the material is in the liquid or soft state.

Scientists know how fast P and S waves travel through the earth. They also know that the speed of these waves changes with depth. If the solid part of the earth were made of the same kind of rock, then the change in speed would be constant.

But the change of speed is not constant. At various depths within the earth, the waves speed up or slow down. They also change direction. These changes of speed of the waves indicate that the solid part of the earth's interior is made up of layers of different kinds of rocks. The speed changes of waves also tell us the depth and thickness of each layer. They further provide clues about the chemical make up of the rocks.

WHAT IS THE EARTH'S CRUST MADE OF?

3

mineral: a natural solid that has a definite chemical formula

rock: a solid material made up of different minerals

element: matter that is made up of only one kind of atom

compound: matter that is made up of two or more elements

crystal: a solid arrangement of atoms and molecules that form regular and repeating plane surfaces.

AIM | What is the earth's crust 3 | made of?

Many people like to collect rocks and study them. Almost no matter where you live, there are some kinds of rocks nearby.

Rock is the hard, solid part of the earth. Broken-up rock is known as boulders, gravel, stones, sand, and rock flour. Most rocks are made of combinations of minerals. But some rocks consist of only one mineral, such as rock salt, or halite.

Some rocks are mined because they contain useful minerals. Some rocks are used as blocks for building.

MINERALS

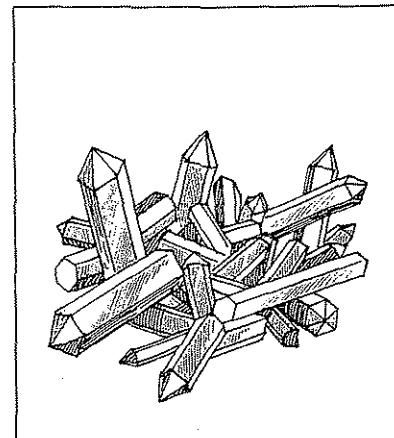
- Minerals are solids, which come from the earth. They are not laboratory made.
- Each mineral has the same chemical compounds wherever it is found. Therefore it has definite properties by which it is identified.
- The atoms and molecules of a mineral are joined in regular patterns called CRYSTALS.

About 2,000 minerals have been found. Oxygen is part of many minerals. Minerals containing oxygen make up almost half of the earth's crust.

ROCKS

- Rocks are *solids*.
- Most rocks are mixtures of two or more minerals.
- Some rocks have some materials that were once alive. Coal is a rock. It was formed from dead trees.
- A rock has *no definite ingredients*. One part of a rock may be different from another part.
- Rocks are grouped by the way they were formed:
 1. from volcanoes,
 2. from fine material that has settled, then hardened,
 3. from heat and pressure under the ground.

MINERALS AND ROCKS



A. QUARTZ

Quartz is a common mineral.

Quartz comes in many colors and sizes . . . but its natural shape is always the same.

The natural shape of a mineral is called its *crystal form*.

The shape of a mineral's crystals helps us identify the mineral.

Look at figure A.

1. a) How many sides does the mineral quartz have? _____
- b) Does a quartz crystal always have this many sides? _____

2. What do we call the natural shape of a mineral? _____

Quartz is also known as silicon dioxide. Quartz is made of silicon and oxygen.

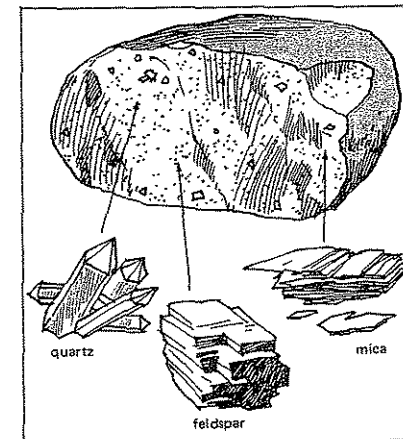
3. Does the formula for quartz ever change? _____
4. Is every part of quartz the same? _____

Granite is a common rock.

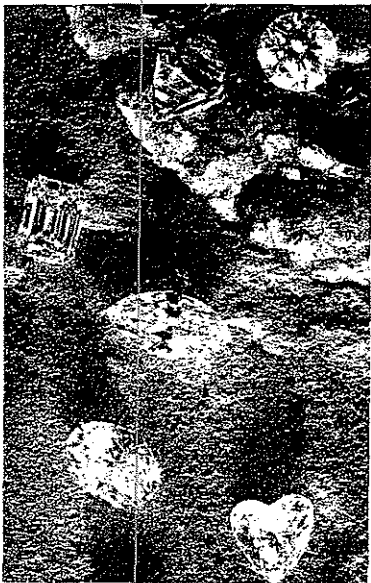
Granite is a mixture of the minerals quartz, feldspar, and at least one other mineral, like mica, or hornblende.

Look at figure B.

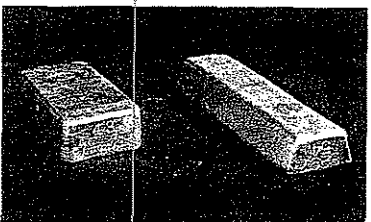
5. Is every part of granite the same? _____
6. Does granite have a definite formula? _____



B. GRANITE



C.



D.



E.

Some minerals are rare and expensive.

Diamonds, rubies, and emeralds are examples of such minerals.

7. What are these minerals used for?

8. a) Are the shapes shown here their natural shapes? _____

b) How did they get that way?

Gold and silver are also minerals.

9. What is one of their important uses?

Talcum powder is made from the mineral talc.

10. Talc is a _____ mineral.
hard, soft

COMPLETING SENTENCES

alive
minerals
build-up of fine materials
properties

do not
found in nature
volcanoes
two thousand

does
formed
oxygen
heat and pressure

- Minerals are always _____.
- Minerals are formed from substances that were never _____.
- A mineral _____ have a definite chemical make-up.
- Minerals have definite _____ that help us identify them.
- About _____ minerals are known.
- The most common element found in minerals is _____.
- Most rocks are mixtures of two or more _____.
- Rocks _____ have a definite chemical make-up.
- Rocks are grouped by how they were _____.
- Rocks are formed in three ways, from _____, _____ and _____.

MATCHING

Match the two lists. Write the correct letter on the line next to each number.

- | | |
|--|----------------------------------|
| 1. _____ mineral | a) help us identify substances |
| 2. _____ rock | b) a rock |
| 3. _____ properties | c) definite chemical make-up |
| 4. _____ a mixture of two or more minerals | d) made up of rocks and minerals |
| 5. _____ earth's crust | e) no definite ingredients |

TRUE OR FALSE Write T on the line next to the number if the sentence is true.
Write F if the sentence is false.

1. _____ The earth's crust is made up only of rocks.
2. _____ Minerals are made from rocks.
3. _____ Every part of a mineral is the same.
4. _____ Every part of a rock is the same.
5. _____ A mineral has a definite chemical make-up.
6. _____ A rock has a definite chemical make-up.
7. _____ Most minerals are compounds.
8. _____ About 200 minerals are known.
9. _____ Minerals contain material from dead plants and animals.
10. _____ Rocks are grouped according to size.

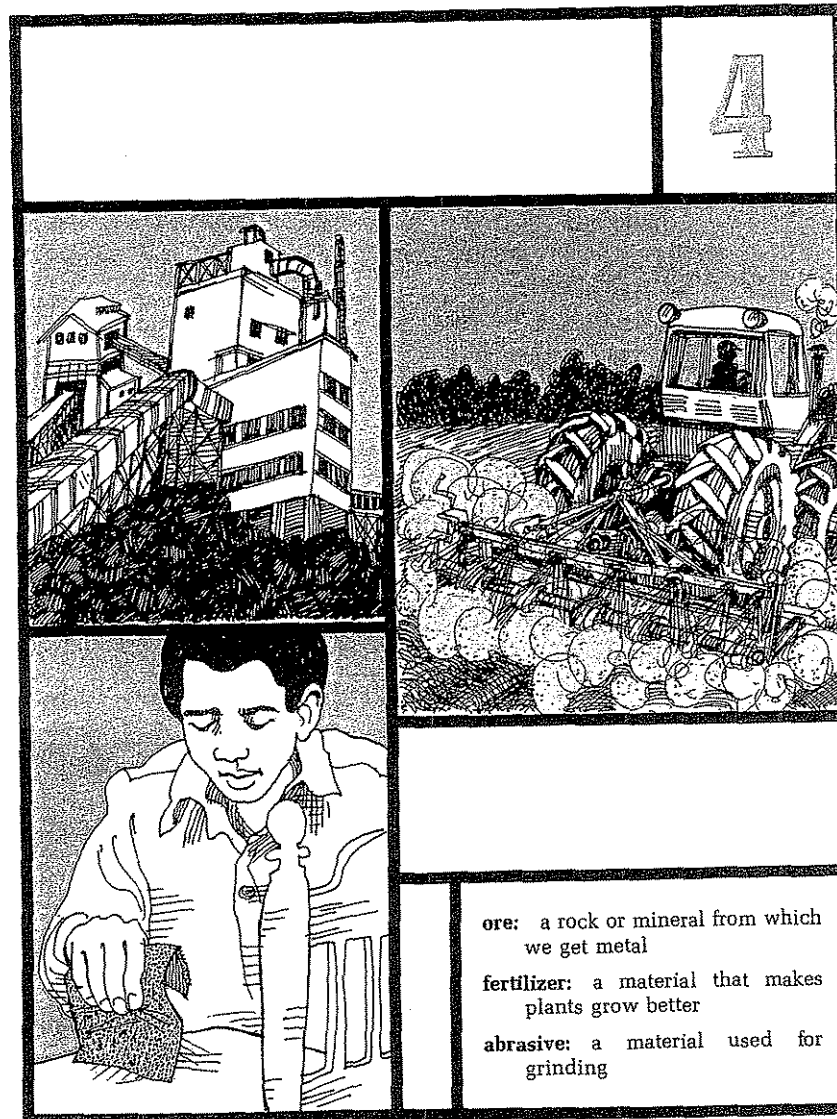
MINERAL OR ROCK?

Put a check (✓) in the correct box.

	Mineral	Rock
1. definite chemical make-up		
2. no definite chemical make-up		
3. made of matter that was never living		
4. sometimes has matter that was once living		
5. properties always the same		
6. mixture of minerals		
7. diamond		
8. granite		
9. quartz		
10. talc		

WHAT ARE SOME USES OF MINERALS?

4



AIM | What are some uses of 4 | minerals?

Many minerals are beautiful. Diamonds, sapphires, rubies, and emeralds are beautiful—and expensive. They are often worn as jewelry. So are other, less precious, minerals.

But minerals—even diamonds—have practical uses too. Here are a few examples.

Cutting and grinding Diamonds are the hardest minerals. Diamonds are important in industry. They are used for cutting and grinding.

Abrasives Things used for rubbing are called abrasives (uh BRAY sivz). Abrasives are used for removing dirt—like scouring powder. Aluminum oxide and quartz are two minerals used as abrasives. They are also used for polishing—like sandpaper. Quartz is used to make most sandpaper.

Glass-making Quartz is the most important part of glass.

Plaster Gypsum (JIP sum) is used in plaster of paris, an important building material.

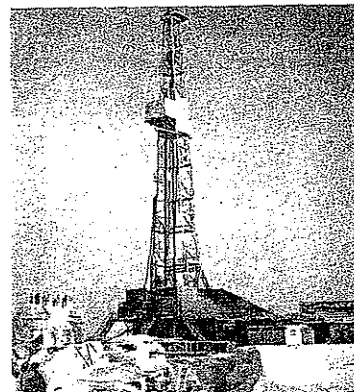
Energy Uranium is supplying more and more of our energy. Uranium supplies atomic energy.

Metal products Most metals come from minerals. We need metals for cooking, building, and many other uses. A mineral that can give us metal is called an ore. Ores are melted to give us metals.

Farming Mineral fertilizers help farmers grow bigger, healthier food crops.

People use great amounts of minerals. We must not waste them. We must learn ways to reuse minerals and to use them wisely. Nature is not putting back what people have taken out.

USING MINERALS



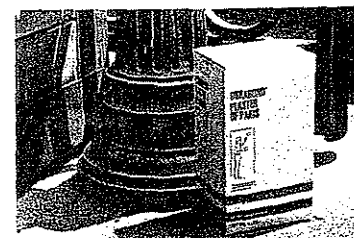
A.



B.



C.



D.

Some drill bits are tipped with diamond.

1. Diamond is _____ than rock.
harder, softer

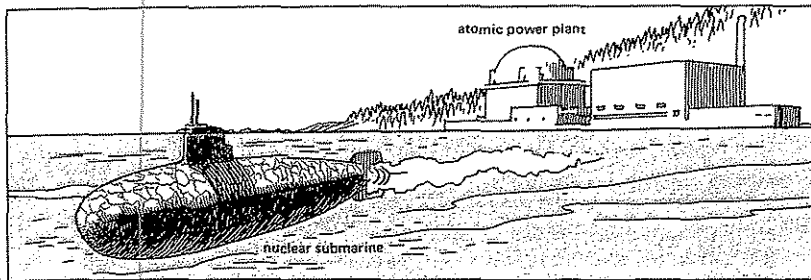
2. Diamond is _____ than steel.
harder, softer

3. What would you use to clean this sink? _____

4. Which minerals might this product have? _____ or _____

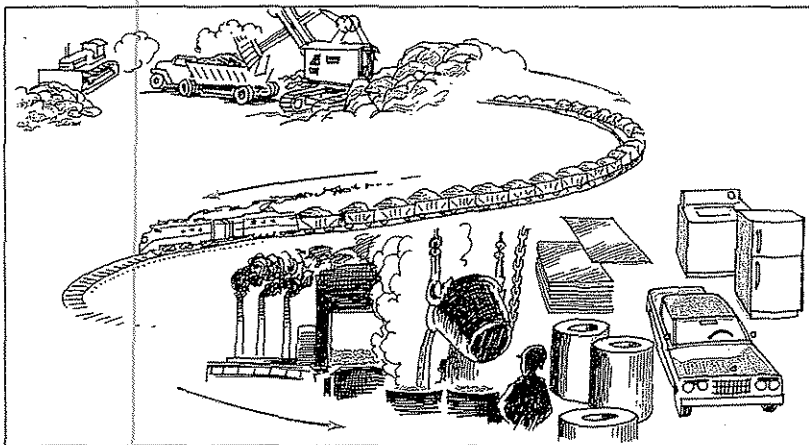
5. Which mineral is used for most sandpaper? _____

6. Which mineral made these building materials possible? _____



E.

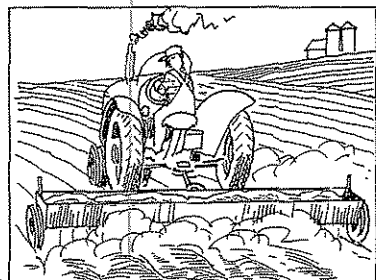
7. Which mineral gives us atomic energy? _____



F.

Metal—from the earth to a finished product.

8. What do we call a mineral from which we get metal? _____



G.

9. What do we call minerals that help farmers grow large, healthy crops?

COMPLETING SENTENCES

Complete the sentences with the choices below. One of these may be used twice.

uranium
last forever
quartz

jewelry
rough
ores

hard
melt
gypsum

1. An abrasive feels _____.
2. The mineral most often used as an abrasive is _____.
3. Diamonds are used in industry because they are so _____.
4. Precious minerals are used mostly as _____.
5. Glass is made mostly of _____.
6. Plaster of paris contains the mineral _____.
7. We get atomic power from the mineral _____.
8. Minerals that give us metals are called _____.
9. To get metal from an ore, we must _____ the ore.
10. Our supply of ores will not _____.

MATCHING Match the two lists. Write the correct letter on the line next to each number.

- | | |
|--------------------|-------------------------|
| 1. _____ abrasives | a) contain metal |
| 2. _____ ores | b) a precious gem stone |
| 3. _____ glass | c) a modern fuel |
| 4. _____ sapphire | d) is mostly quartz |
| 5. _____ uranium | e) are rough |

TRUE OR FALSE Write T on the line next to the number if the sentence is true.
Write F if the sentence is false.

1. _____ Diamonds are used only as jewelry.
2. _____ An abrasive is rough.
3. _____ Diamond is good for grinding and cutting.
4. _____ Gypsum is an important part of glass.
5. _____ Every mineral is an ore.
6. _____ There is only one kind of ore.
7. _____ Metals come from ores.
8. _____ Diamond is harder than steel.
9. _____ Talc is used as an abrasive.
10. _____ Diamond is important in industry.

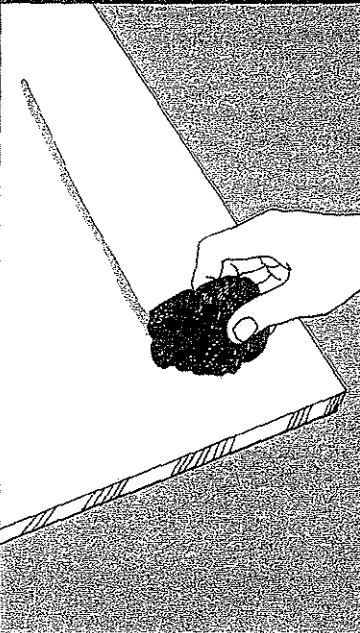
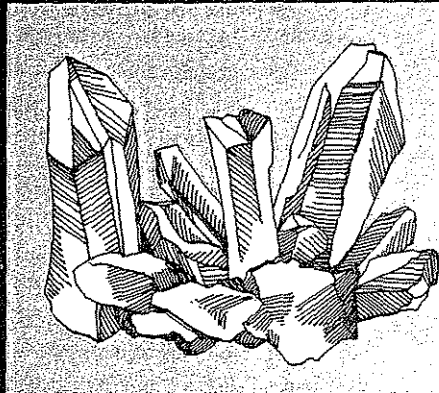
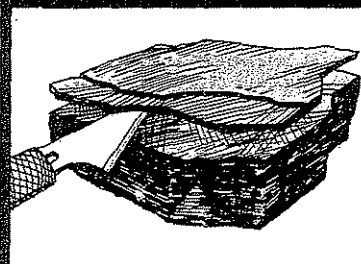
REACHING OUT What steps should we take to keep our supplies of minerals from running out?

WORD SCRAMBLE Unscramble each of the following to form a word or term that you have read in this Aim.

1. BRAVESAI _____
2. MADNOID _____
3. ROE _____
4. SGALS _____
5. UPSMYG _____

HOW CAN WE IDENTIFY MINERALS?

5

density: the weight of a substance compared to the weight of another of the same size

luster: shine

cleavage: the pattern in which a mineral splits

streak: the color of a mineral's powder

AIM | How can we identify 5 minerals?

Have you ever heard of "fool's gold"? It looks like gold, but it is another mineral. It is worth far less than gold. Many people have been fooled by it.

Many minerals have "look-alikes." That is why scientists have come up with tests to identify minerals. Sometimes, only one test is needed. More often several are needed.

These are the most important tests:

HARDNESS Minerals have different hardnesses. To find out how hard a mineral is, we test it against other minerals. Ten minerals whose hardnesses are known are used for this test. Diamond and talc are two of these minerals. Diamond is the hardest mineral. Talc is the softest.

DENSITY Density is the weight of a substance compared to its volume. Different minerals have different densities.

COLOR Some minerals are colorless. Others come in just about any color you can imagine.

LUSTER The kind of shiny quality a mineral has is its luster.

CRYSTAL FORM Crystal form is the natural form of some—but not all—minerals. Crystal form helps identify some minerals.

CLEAVAGE The way a mineral splits is called cleavage. Some minerals split in definite patterns. Others do not.

STREAK When you rub a mineral on a hard, rough, white surface, it may leave a streak of powder. The color of its streak is important. Some minerals leave no streak.

ACID TEST The mineral calcite is tested with dilute hydrochloric acid. Bubbles are given off if calcite is present. Dilute hydrochloric acid is used to test for the mineral calcite.

TESTING MINERALS

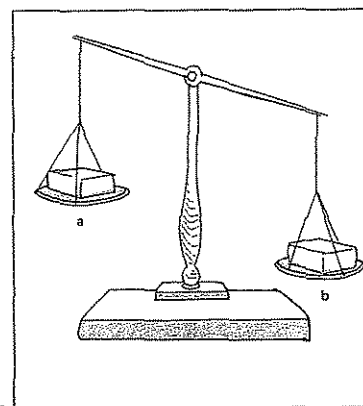
MINERAL HARDNESS SCALE		
	Hardness	Mineral
Softest ↓ Hardest	1	talc
	2	gypsum
	3	calcite
	4	fluorite
	5	apatite
	6	feldspar
	7	quartz
	8	topaz
	9	corundum
	10	diamond

The Mineral Hardness Scale shows the ten minerals that we test other materials against. When a material is tested for hardness, it is given a number to show how hard it is. A material with a hardness of 2.5 would be harder than gypsum, but softer than calcite. A mineral can scratch something softer, but not something harder.

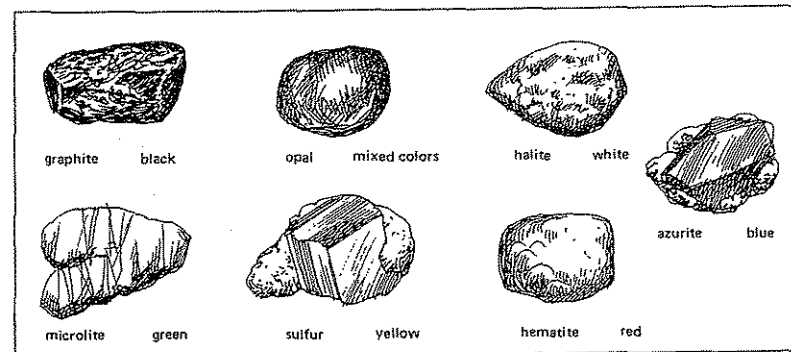
1. Which mineral cannot scratch any mineral but itself? _____
2. Which is harder, calcite or topaz? _____

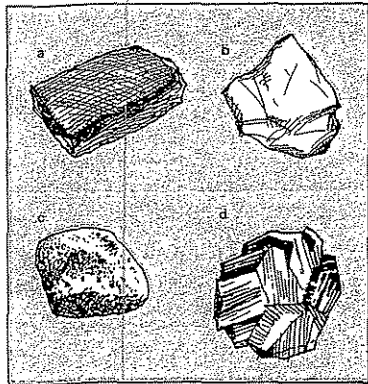
Study diagram A and answer these questions.

3. Which weighs more, mineral a or b? _____
4. The chunks of minerals a and b are of _____ sizes.
the same - different
5. Mineral b is _____ denser, less dense
than mineral a.

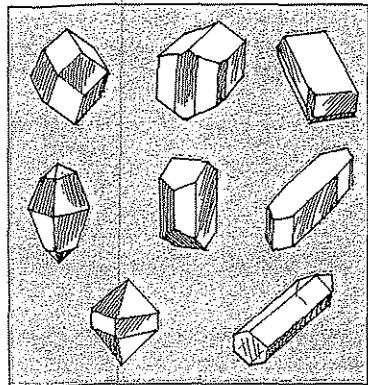


Minerals come in many colors.

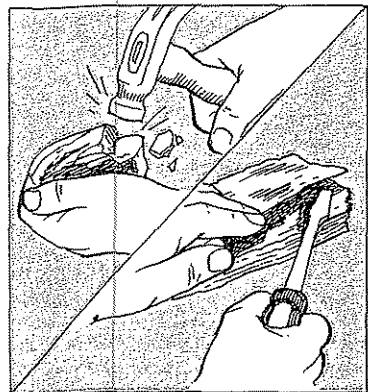




C.



D.



E.

Luster is divided into two classes —metallic, and nonmetallic.

Minerals that shine like metal have *metallic* luster.

Minerals that do not shine like metal have *nonmetallic* luster. (There are several kinds of nonmetallic lusters)

Can you identify these lusters? Write the correct letters next to each luster.

6. metallic _____

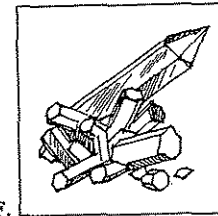
7. nonmetallic _____

There are many crystal forms. Which one is quartz? Circle it.

8. Do all minerals form crystals?

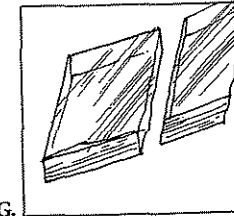
9. What instruments can be used to show the cleavage of minerals?

There are many kinds of cleavage. Here are three examples:



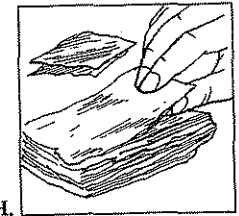
F.

Quartz shows no definite cleavage pattern.



G.

Calcite cleaves in a very definite pattern.



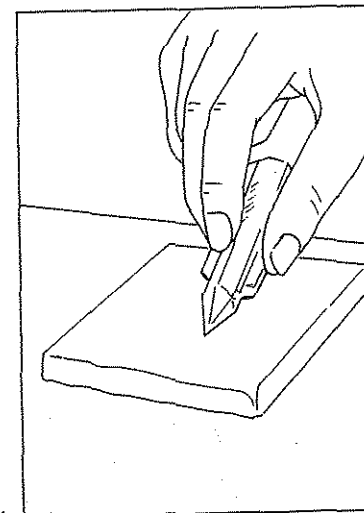
H.

Mica cleaves easily in thin flat sheets.

Streaking is done by rubbing a mineral on a hard, rough white surface. The streak is the color of the mineral's powder.

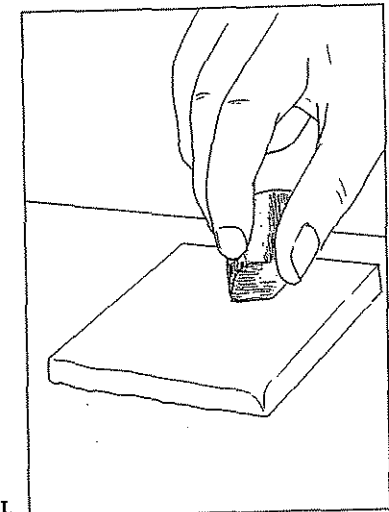
■ Some minerals leave no streak.

■ Some minerals streak the same color as the mineral. Some streak a *different* color than the mineral.



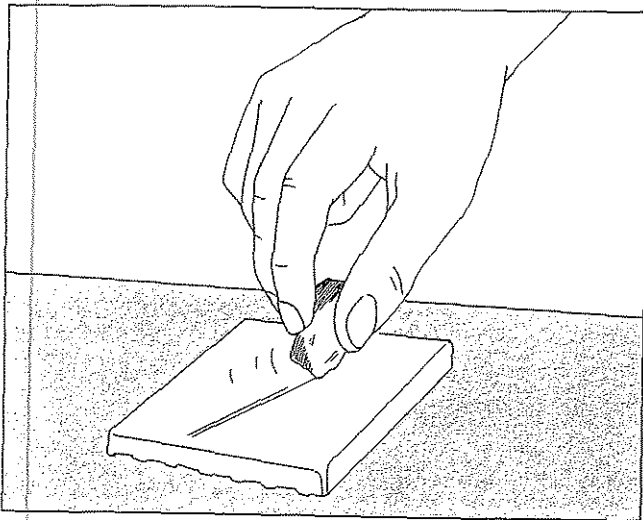
I.

The mineral quartz leaves no streak.



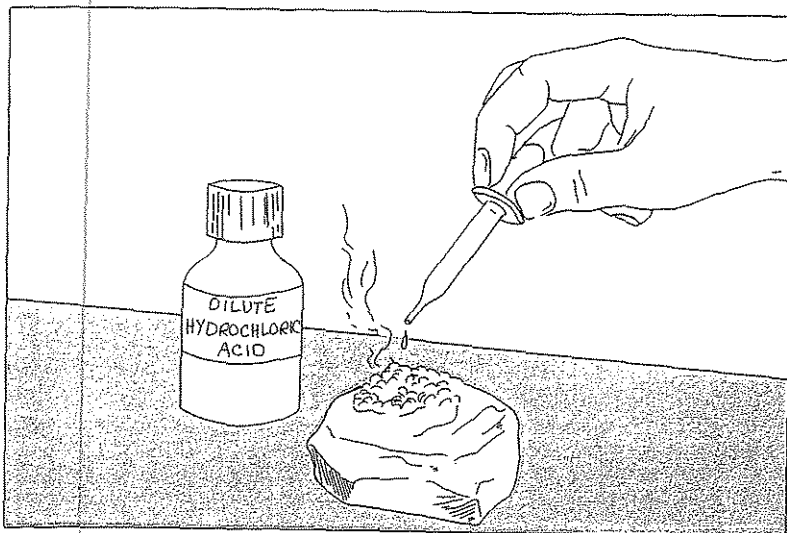
J.

The mineral iron pyrite is yellow. But it streaks greenish-black.



K.

Gold streaks its own color.



L.

Bubbles are given off if calcite is present.

COMPLETING SENTENCES Complete the sentences with the choices below.

ten
luster
powder
diamond

breaks
density
crystal form

share
calcite
talc

1. There are _____ minerals on the hardness scale.
2. The hardest mineral is _____.
3. The softest mineral is _____.
4. Metallic and nonmetallic are kinds of _____.
5. The natural shape of mineral is called its _____.
6. Cleavage is shown when a mineral _____.
7. Streak is the color of a mineral's _____.
8. The weight of a mineral compared to its volume is called its _____.
9. Dilute hydrochloric acid tests for the mineral _____.
10. Often, several minerals _____ some properties.

MATCHING Match the two lists. Write the correct letter on the line next to each number.

- | | |
|-----------------------------------|--------------------------------|
| 1. _____ streak | a) wet test for calcite |
| 2. _____ cleavage | b) pattern of split mineral |
| 3. _____ crystal form | c) the two classes of luster |
| 4. _____ hydrochloric acid | d) color of a mineral's powder |
| 5. _____ metallic and nonmetallic | e) a mineral's natural shape |

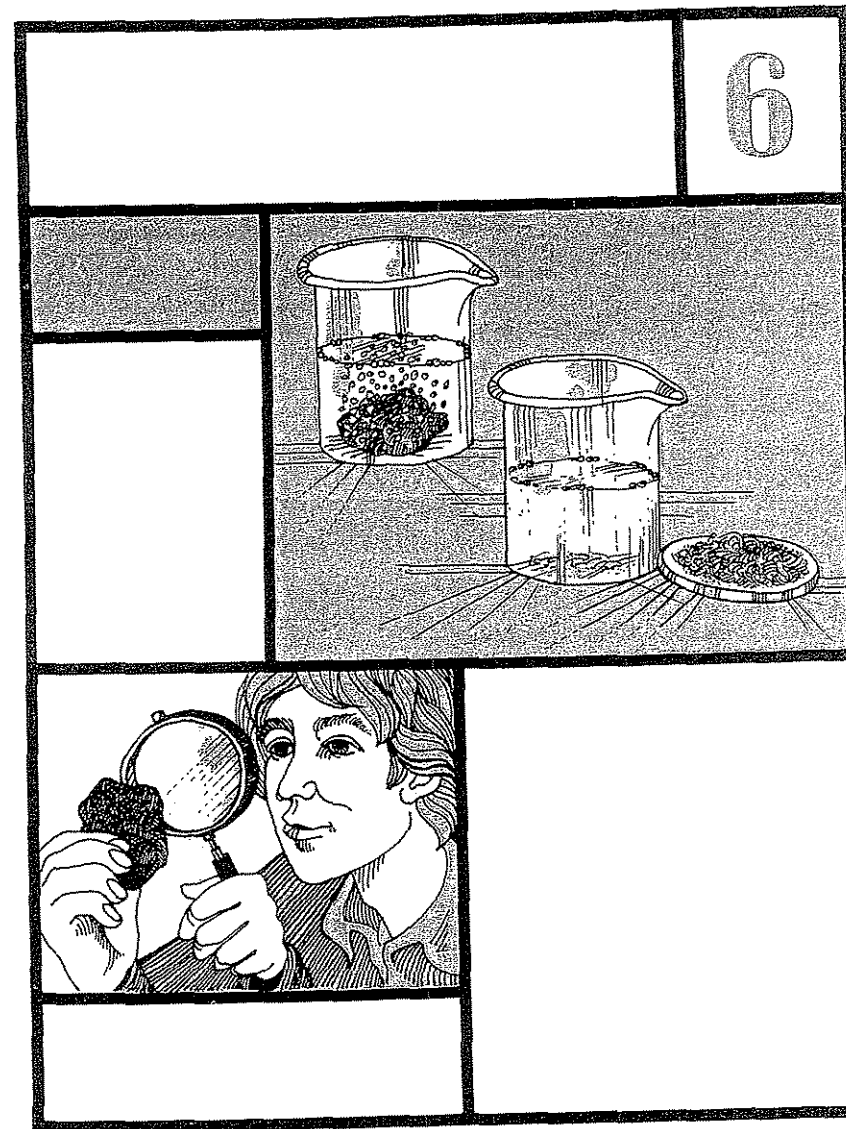
TRUE OR FALSE Write T on the line next to the number if the sentence is true.
Write F if the sentence is false.

1. _____ All minerals have the same hardness.
2. _____ Minerals come in many different colors.
3. _____ Every mineral has a color.
4. _____ Every mineral has a crystal form.
5. _____ A mineral may have a crystal form but no cleavage.
6. _____ Some minerals leave no streak.
7. _____ A mineral's streak is always the same color as the mineral.
8. _____ Hydrochloric acid makes calcite bubble.

REACHING OUT Iron pyrite is sometimes known as "fool's gold." If you had a yellow mineral, what would be one test you could use to see if it were real gold or iron pyrite?

HOW CAN WE TEST MINERALS IN CLASS?

6



AIM | How can we test minerals in 6 class?

Let's do some testing! You will get samples of some minerals. You will also get some materials to test them with. Your job is to fill in the chart.

What You Need

quartz
pyrite
calcite

galena
hematite

white surface for
streak test
dilute hydrochloric
acid

	Quartz	Pyrite	Calcite	Galena	Hematite
Color					
Kind of luster (metallic or nonmetallic)					
Does it streak? What color?					
Does it react with hydrochloric acid?					

STUDYING MINERAL HARDNESS

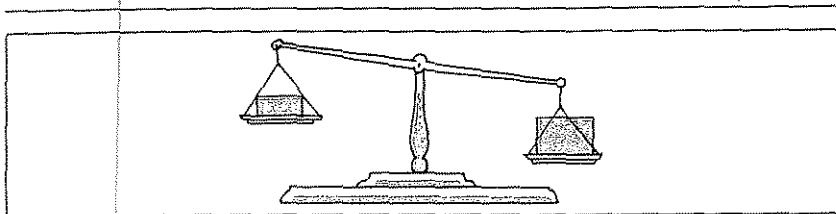
Use the Hardness Scale on page 27 to answer these questions.

- Name the minerals that gypsum can scratch. _____
- Name the minerals that gypsum cannot scratch. _____
- Name the minerals that are harder than topaz. _____
- Name the mineral that can be scratched by all minerals. _____
- Name the mineral that can be scratched by only one mineral. _____
- A copper penny has a hardness of 3.0. List the minerals that are softer than a copper penny. _____
- List the minerals that a copper penny can scratch. _____
- A fingernail has a hardness of 2.5. Name the minerals that a fingernail can scratch. _____
- A steel nail has a hardness of 6.7. Which minerals can a steel nail scratch? _____
- Which minerals can a steel nail not scratch? _____

WHICH TEST? Eight terms are listed below. Each one suggests a certain mineral test. Which one is it? Write the test on the correct line.

- soft _____
- rough, white surface _____
- crack _____
- liquid chemical _____
- nature's design _____
- reflection _____
- solid blue _____
- smaller but heavier _____

REACHING OUT What's wrong?



Why is this not the right way to compare densities? (Hint: Check page 26 for a clue.)

WORD SEARCH

The words in this list are hidden within the groups of letters. Try to find each word. When you find it, draw a line around the word. The spelling may go backwards or forwards in any direction: up-and-down, across, or diagonally.

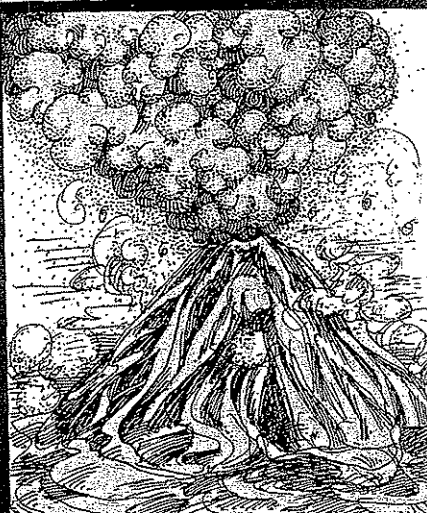
QUARTZ
DIAMOND
URANIUM
GYPSUM
DENSITY
CLEAVAGE
STREAK
LUSTER
HARDNESS
ACID
CRYSTAL

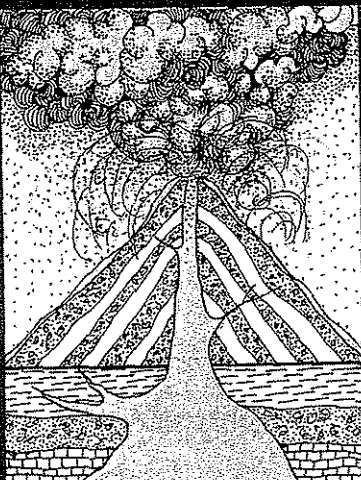
Q	T	D	S	L	L	R	A	D	E	C	R	Q
C	U	I	G	U	U	T	R	G	A	U	Y	Y
R	R	A	Z	Y	I	S	A	U	K	N	T	D
Y	A	M	R	R	P	V	T	A	Q	I	I	D
S	N	O	E	T	A	S	E	E	S	R	U	I
T	I	N	A	E	Z	R	U	N	R	M	P	N
A	U	D	L	C	T	G	E	M	P	N	U	A
L	M	C	Y	S	I	D	C	A	I	D	M	O
I	R	A	H	A	R	D	N	E	S	S	S	M

WHAT ARE IGNEOUS ROCKS?



7





igneous: having to do with fire

magma: melted rock under the ground

lava: melted rock on top of the ground

volcano: one kind of mountain

AIM | What are igneous rocks?

7

There was a time when there were no rocks. Billions of years ago, the earth was just a huge ball of burning gases. As this ball traveled through space it started to cool. The cooling changed the gases to liquids. Then more cooling took place. Some of the liquids changed to solid rock.

Rocks that have hardened from liquids are called igneous [IG nee us] rocks. The word "igneous" comes from the Greek word for fire.

All rocks did not cool the same way. Some cooled slowly, deep under the earth's surface. Others cooled quickly, near or on the surface. Different speeds of cooling made different size crystals.

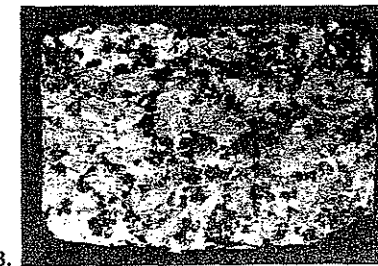
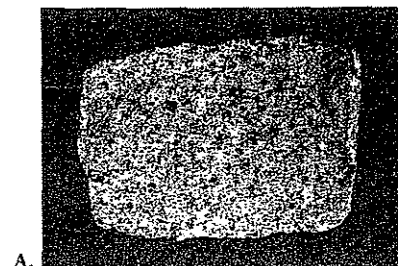
- Slow cooling formed rocks with large crystals.
- Rapid cooling formed rocks with small crystals.
- Extra-fast cooling formed rocks with no crystals.

The longer the cooling, the larger the crystals. The shorter the cooling, the smaller the crystals. If we know this, we can look at a rock and tell if it cooled slowly or quickly.

In some places, there are still hot, melted minerals in the ground. Some of this is slowly turning to rock. The hot, melted matter under the ground is called magma (MAG mah). Sometimes magma forces its way to the surface. Then it is called lava. Lava forms cone-shaped mountains. Most people call these mountains volcanoes.

SOME IGNEOUS ROCKS

I.



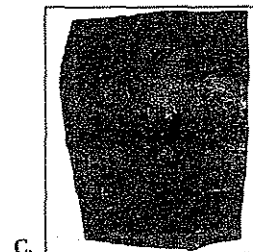
A.

B.

Granite is the most common igneous rock on the earth's surface. Both of these rocks are granite.

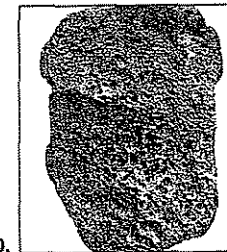
1. a) Which one has larger grains? _____
b) This shows that it cooled _____ slowly, quickly
2. a) Which one has smaller grains? _____
b) This shows that it cooled _____ slowly, quickly
3. Which one cooled deeper under the ground? _____

II.



C.

Basalt crystals are very tiny. You need a microscope to see them.



D.

Pumice has many holes. But these holes are not grains. They were made by gases.



E.

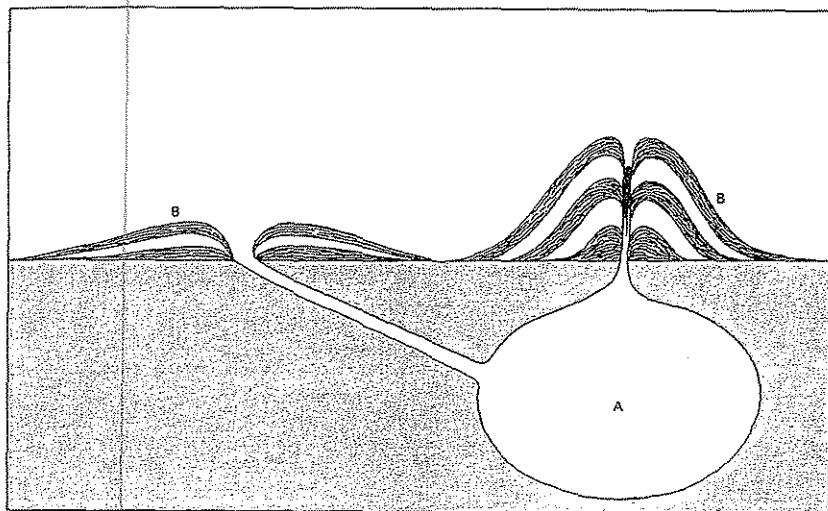
Obsidian is called "natural glass."

Pumice and obsidian have no crystals.

4. Basalt grains are small because of _____ fast, slow _____ cooling.
5. Pumice and obsidian cooled _____ extra fast, extra slow _____

WHAT DOES THE DIAGRAM SHOW?

Study this diagram. Then answer the questions below. You will have to figure out the answers from facts you have learned.



This diagram shows two mountains built from underground materials. It also shows the underground materials that built them.

1. Lava is found at _____
A, B
2. Magma is found at _____
A, B
3. Magma cools _____ because it is _____
slowly, rapidly under the ground, above the ground
4. Lava cools _____ because it is _____
slowly, rapidly under the ground, above the ground
5. Large-grain rocks form from _____
lava, magma
6. Rocks with small grains or no grains at all form from _____
lava, magma
7. Granite has _____ grains.
large, small, no
8. Pumice has _____ grains.
large, small, no
9. Granite may form at _____
A, B
10. Pumice may form at _____
A, B

COMPLETING SENTENCES

Complete the sentences with the choices below. Two of these may be used twice.

large
magma
small

melted
lava
volcano

granite
crystal
slowly

1. Igneous rocks were formed from _____ minerals.
2. Melted rock under the ground is called _____.
3. Melted rock that comes to the surface is called _____.
4. Lava may form a mountain called a _____.
5. An example of an igneous rock formed from magma is _____.
6. Granite grains are _____ in size because granite cooled _____.
7. Grain size is another way of saying _____ size.
8. Basalt crystals are _____ in size.
9. Melted minerals that cool slowly form _____ size crystals.
10. Melted minerals that cool rapidly form _____ size crystals.

MATCHING

Match the two lists. Write the correct letter on the line next to each number.

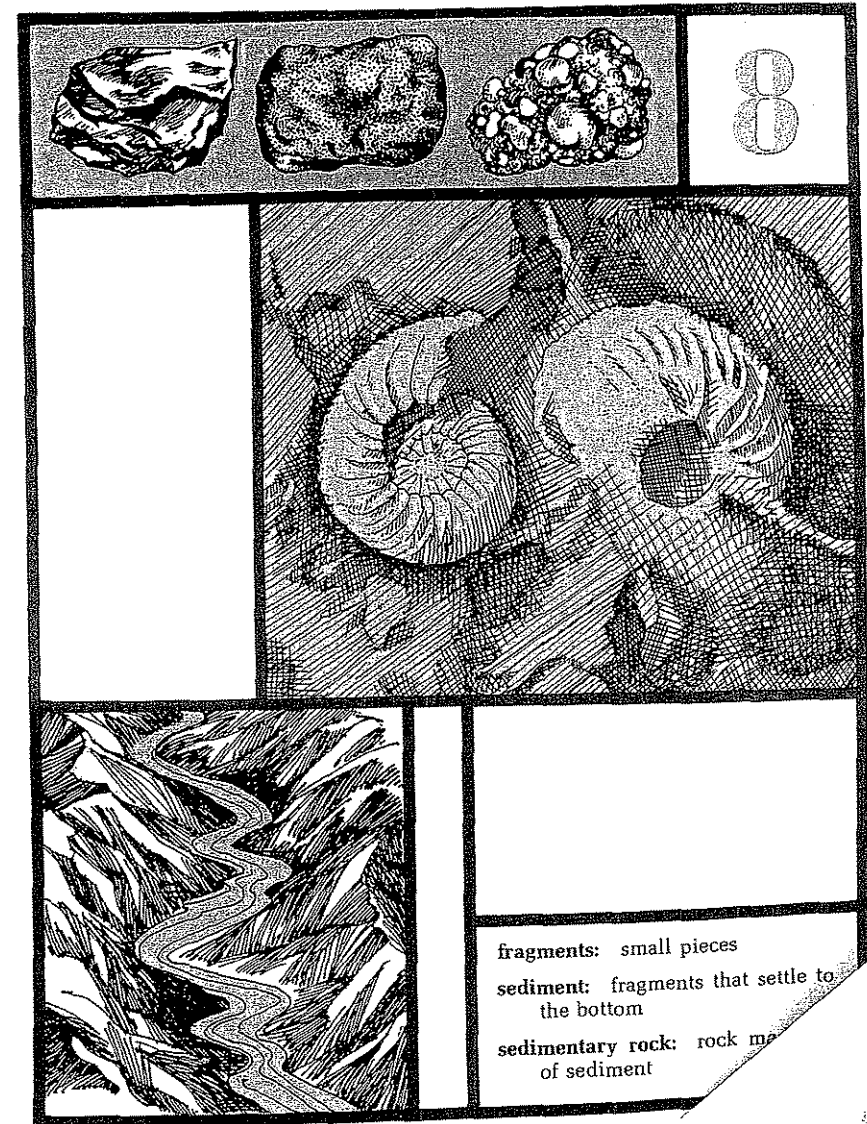
- | | |
|-----------------------|-------------------------------------|
| 1. _____ magma | a) grain |
| 2. _____ lava | b) from fast cooling |
| 3. _____ crystal | c) melted minerals on the surface |
| 4. _____ large grains | d) melted minerals below the ground |
| 5. _____ small grains | e) from slow cooling |

TRUE OR FALSE

Write T on the line next to the number if the sentence is true.
Write F if the sentence is false.

1. _____ Magma is solid.
2. _____ Magma contains minerals.

WHAT ARE SEDIMENTARY ROCKS?



3. _____ All rocks were once liquid.
4. _____ Magma is melted rock that has come to the surface.
5. _____ Lava cools faster than magma.
6. _____ Granite formed underground.
7. _____ Granite cooled rapidly.
8. _____ Granite has small grains.
9. _____ Lava rocks usually have large grains.
10. _____ Fast cooling causes small grains.
11. _____ Basalt is an igneous rock.
12. _____ Basalt cooled slowly.
13. _____ Basalt has small grains.
14. _____ Pumice was formed deep underground.
15. _____ Pumice has no grains.

THROW ONE OUT In each of the following sets of terms, one of the terms does not belong. Circle that term.

1. granite, fine grain, coarse grain
2. granite, slow cooling, fast cooling
3. granite, formed above ground, formed underground
4. very slow cooling, very fast cooling, no crystals
5. lava, underground, above ground

REACHING OUT One of the rocks discussed in this Aim can float on water.

1. Which rock is it? _____
2. Why can it float? _____

AIM | What are sedimentary 8 rocks?

The tallest mountain in the world is Mount Everest, in Asia. People have risked their lives trying to climb it. But someday, Mount Everest will be completely worn away. It is wearing away right now, a little bit at a time. It will take millions of years for Mount Everest to wear away, but it will happen.

There are forces in nature that keep breaking rocks into smaller and smaller pieces. These broken pieces are called fragments. Pebbles, gravel, sand, and clay are some kinds of rock fragments.

Fragments are moved about by water, wind, and frozen water called glaciers [GLAY sherz]. The fragments settle in a new place and begin to pile up. The settled fragments are called sediment [SED uh ment]. Sediment is always laid down in flat layers. Sediment can harden into solid rock.

Rock that is formed from hardened sediment is called sedimentary (sed uh MENT ree) rock. Sediment can harden into sedimentary rock in two ways:

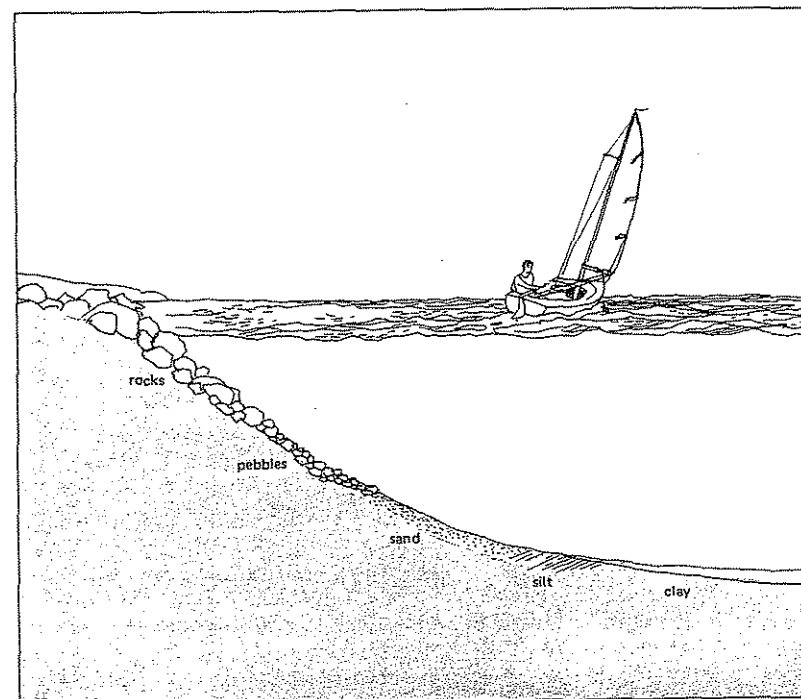
1. from the pressure of its own weight, or
2. by cementing. Minerals dissolved in water "glue" the sediment together.

Most sediment builds up under water. The thickest sediment is found where rivers empty out into shallow oceans. Some sediment comes from living matter, such as coal that has hardened from dead trees.

Different kinds of sediment form different kinds of sedimentary rocks.

WHAT DOES THE PICTURE SHOW?

Look at the picture. Then answer the questions.

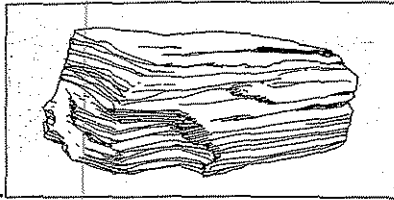


A.

Rivers carry much sediment. When a river empties into a lake or ocean, it drops its sediment. The heaviest sediment settles first. Then the lighter sediment settles.

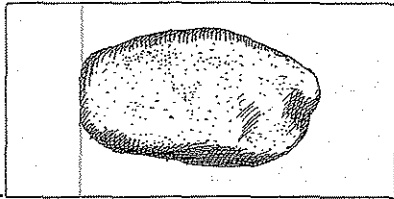
1. List the kinds of sediment this diagram shows. _____
2. a) Which sediment is the heaviest? _____
b) Which is the lightest? _____
c) Which was laid down first? _____
d) Which was laid down last? _____
3. Choose one. Put a check (✓) on the line before the correct statement.
_____ a) Oceans supply water to rivers.
_____ b) Rivers supply water to oceans.

EXAMPLES OF SEDIMENTARY ROCKS



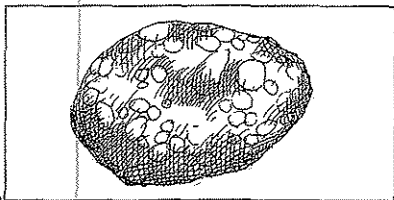
Shale is a sedimentary rock. It was formed from mud and clay pressed together by nature.

Shale is a very soft rock. It breaks easily.



Sandstone was formed in water from sand grains. Minerals dissolved in the water cemented the grains together.

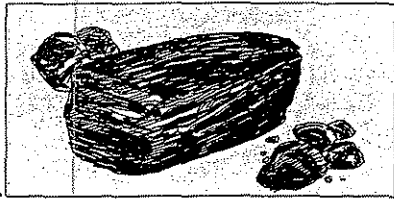
Sandstone grains are held together loosely. They can be rubbed off easily.



A conglomerate is a sedimentary rock. It is made of grains of sand and pebbles.

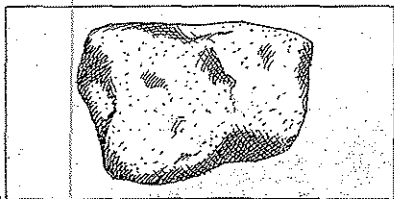
The grains were cemented together by minerals dissolved in water.

Conglomerate is also called puddingstone.



Soft coal is considered a sedimentary rock.

Soft coal was formed from layers of dead plants.



Limestone is a sedimentary rock formed from the shells of dead sea animals.

COMPLETING SENTENCES

Complete the sentences with the choices below.

cementing
sand
fragments
wind
under water
silt

moving water
pebbles
clay
sizes
shale
glaciers

limestone
sedimentary
breaks up
gravel
pressure

- Nature _____ big rocks into smaller and smaller pieces.
- Broken pieces of rock are called _____.
- Rock fragments make up the sediment for a group of rocks called _____ rocks.
- Sediment comes in different _____.
- Examples of sediment are: _____, _____, _____, _____, and _____.
- Sediment is moved by _____, _____, and _____.
- Fragments harden into sedimentary rocks in two ways. The two ways are from _____ and by _____.
- The sedimentary rock made from mud and clay is called _____.
- The sedimentary rock made from the shells of sea animals is called _____.
- Most sedimentary rocks were formed _____.

MATCHING

Match the two lists. Write the correct letter on the line next to each number.

- _____ sedimentary rocks
- _____ limestone
- _____ shale
- _____ in water
- _____ sediment

- anything that settles
- where most sediment builds up
- group of rocks formed from rock fragments
- formed from mud and clay
- formed from shells of sea animals



TRUE OR FALSE Write T on the line next to the number if the sentence is true.
Write F if the sentence is false.

1. _____ All rocks are sedimentary rocks.
2. _____ Sedimentary rocks came before igneous rocks.
3. _____ Sedimentary rocks are made of rock fragments.
4. _____ Most sedimentary rocks were formed under water.
5. _____ All sedimentary rocks were hardened by natural cement.
6. _____ Nature only wears things down. (Think about this one carefully.)
7. _____ Sedimentary rocks can come from other sedimentary rocks.
8. _____ Sand fragments settle faster than pebbles do.
9. _____ Most fragments are carried away by moving water.
10. _____ Sediment is laid down in slanted layers.

WORD SCRAMBLE Unscramble each of the following to form a word or term that you have read in this Aim.

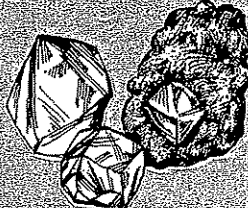
1. GENTSFRAM _____
2. MESTDINE _____
3. SEENOTMIL _____
4. VAGLER _____
5. HALES _____

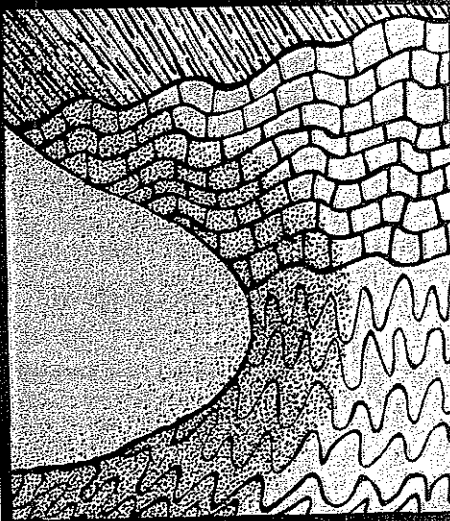
REACHING OUT What are some of the forces in nature that wear down rocks?

WHAT ARE METAMORPHIC ROCKS?




9



metamorphic rock: changed-over rock

gneiss: a metamorphic rock

slate: a metamorphic rock

marble: a metamorphic rock

quartzite: a metamorphic rock

AIM | What are metamorphic 9 | rocks?

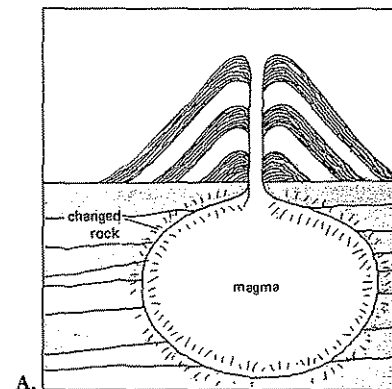
Many things we use are changed over from what they were to begin with. Glass, plastic and synthetic fabrics do not look like the raw materials they came from. Many of the things we use were changed. Some things were changed by heat and pressure.

Heat and pressure can change many things. They can even change rocks. The name for changed-over rocks is *metamorphic* [met uh MOR fik] rocks. Metamorphic comes from Greek words meaning "change" and "form."

Metamorphic rocks are formed deep in the earth where there is high temperature and great pressure. The heat and pressure change one kind of rock into another kind of rock. The new rocks become harder than the old rocks. They also look different. Sometimes the minerals in the rocks change too.

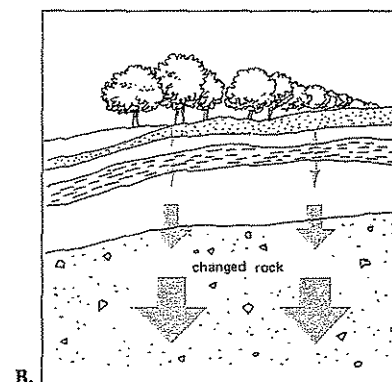
The pressure that changes rocks can also tilt and fold them. Folding can lift rocks and make them into high mountains.

There are many kinds of metamorphic rocks. Slate is a metamorphic rock. Slate is changed-over shale. Marble is another metamorphic rock. Marble is changed-over limestone.



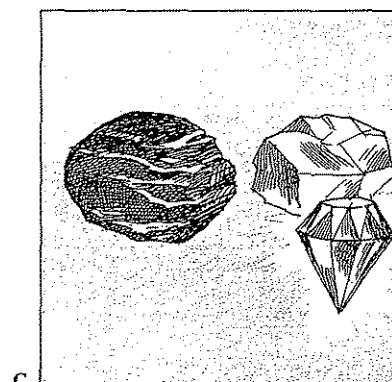
Heat, by itself, can change rocks.

Heat from magma may change the rocks next to the magma.



Heat and pressure together can change rocks.

The weight of layer upon layer of rocks causes pressure. Pressure builds heat. Heat and pressure change rocks.



Coal is mostly carbon. So is diamond.

Diamond is changed-over carbon.

COMPLETING SENTENCES Complete the sentences with the choices below.

slate
great pressure
look
sedimentary

marble
harder
mountains
great heat

igneous
fold
metamorphic

1. Rocks formed from melted minerals are called _____ rocks.
2. Rocks formed from sediment are called _____ rocks.
3. Changed-over rocks are called _____ rocks.
4. Two things that can change rocks to other kinds of rocks are _____ and _____.
5. Pressure makes rocks become _____ than they were.
6. Heat and pressure can change the way rocks _____.
7. Pressure on rocks can make rocks tilt or _____.
8. Folded rocks can become _____.
9. Heat and pressure change shale to _____.
10. Heat and pressure change limestone to _____.

MATCHING Match the two lists. Write the correct letter on the line next to each number.

- | | |
|----------------------------|---------------------------------------|
| 1. _____ metamorphic rocks | a) was once shale |
| 2. _____ heat and pressure | b) place where metamorphic rocks form |
| 3. _____ slate | c) changed-over rocks |
| 4. _____ marble | d) was once limestone |
| 5. _____ deep in the earth | e) change rocks |

SOME COMMON METAMORPHIC ROCKS

Original Rock		Metamorphic Rock	Uses
limestone	changes to	marble	buildings
shale	changes to	slate	roof shingles blackboards slate walks
granite	changes to	gneiss	buildings monuments
soft coal	changes to	hard coal	fuel
sandstone	changes to	quartzite	buildings

TRUE OR FALSE Write T on the line next to the number if the sentence is true. Write F if the sentence is false.

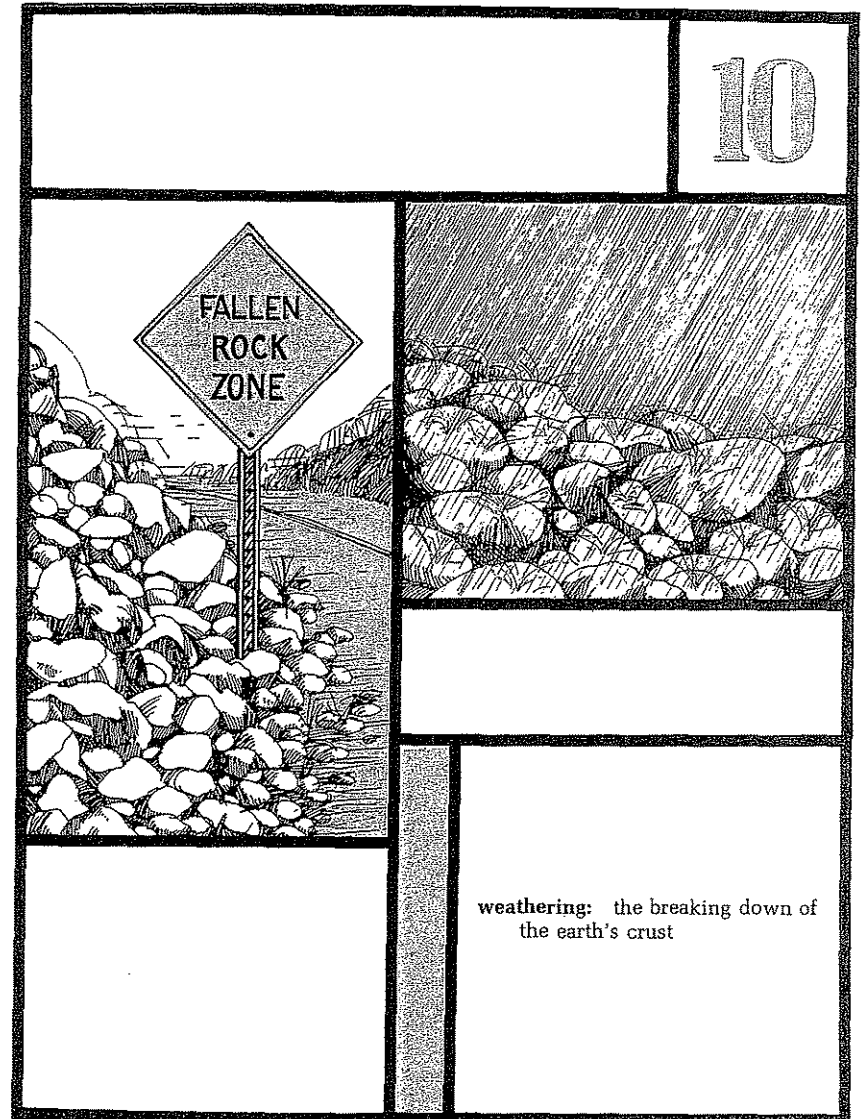
1. _____ Metamorphic rocks are changed rocks.
2. _____ Metamorphic rocks are harder than the original rocks.
3. _____ Only heat can change rocks.
4. _____ Slate is harder than shale.
5. _____ Sedimentary rocks were formed on a slant.
6. _____ Coal is harder than diamond.
7. _____ Minerals in a rock can change the way they look.
8. _____ Slate changes to shale.
9. _____ Gneiss is harder than granite.
10. _____ Our planet is always changing.

WHICH CAME FIRST? In each of the pairs below, one of the things came from the other. On the line next to each pair, write the name of the thing that came *before* the other.

1. sand or sandstone? _____
2. quartzite or sandstone? _____
3. shale or mud? _____
4. slate or shale? _____
5. granite or gneiss? _____
6. marble or limestone? _____
7. plants or soft coal? _____
8. hard coal or soft coal? _____
9. diamond or coal? _____
10. limestone or tiny sea animals? _____
11. sedimentary rocks or sediment? _____

WHAT MAKES THE EARTH'S CRUST CHANGE?

10



AIM | What makes the earth's 10 | crust change?

Earthquake! Tornado! Flood! Exploding volcano! All these cause sudden changes on the earth's crust. Earthquakes and exploding volcanoes create changes from beneath the surface. Tornadoes and floods usually change the crust from above. But all these changes are sudden.

There are changes that take place more slowly. The earth is always changing. It changes from above and from below. Parts of the earth are being worn away. Other parts are building up. These changes are taking place right this minute—without earthquakes or tornadoes. In fact, most of the changes in the earth take place very, very slowly. They take place over a long period of time.

Weathering is the name for the breaking down of the earth's crust into smaller and smaller pieces. Some weathering is caused by plants and animals. But most weathering is caused by the atmosphere.

There are two kinds of weathering: mechanical weathering and chemical weathering.

1. Mechanical weathering breaks rocks into smaller and smaller pieces. It does not change the chemicals of the rocks.
2. Chemical weathering also breaks rocks into smaller pieces. And it changes the chemicals of the rocks.

Weathering breaks rocks down into smaller pieces. It does not carry away the fragments.

COMPLETING SENTENCES Complete the sentences with the choices below.

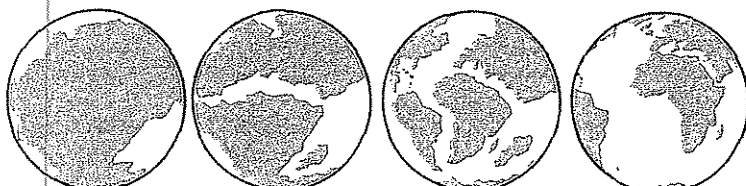
fast	weathering	slowly
breaks rocks down	changing	move them away
chemical weathering	mechanical	mechanical weathering
chemical		

1. The crust of the earth is always _____.
2. Earthquakes, volcanic explosions, and storms cause _____ changes.
3. Most changes happen _____.
4. Rocks are made into fragments by a process called _____.
5. There are two kinds of weathering. They are _____ and _____.
6. In _____ weathering, the chemical make-up of the crust does not change.
7. In _____ weathering, there is a change in the chemical make-up of the crust.
8. Weathering only _____, it does not _____.

MATCHING Match the two lists. Write the correct letter on the line next to each number.

- | | |
|--|---|
| 1. _____ weathering | a) does not change the chemical make-up of rocks |
| 2. _____ chemical weathering | b) the breaking down of the earth's crust by nature |
| 3. _____ mechanical weathering | c) does most weathering |
| 4. _____ atmosphere | d) not part of weathering |
| 5. _____ carrying away of rock fragments | e) changes the chemical make-up of rocks |

KEEPING UP WITH SCIENCE



200 million
years ago

180 million
years ago

80-120 million
years ago

Present

DRIFTING CONTINENTS

Look at the map of the earth. Notice the east coast of North and South America and the west coast of Europe and Africa. They look as though they must have fitted into each other at one time. Is this possible? In fact, all the continents look like pieces of a giant jigsaw puzzle.

By the 16th century much of the earth had been mapped. People noticed the shapes of the continents and how they seemed to fit into each other. They guessed that early in the earth's history there was only one large continent. Later this supercontinent split into several parts. These parts somehow drifted away, forming continents as we see them on our maps.

Scientific studies in the 1800s supported this idea. Geologists discovered that rocks along the east coast of South America are similar to those along the west coast of Africa. Why? Biologists found that certain rare animal species exist only in east Africa and India. Why?

In spite of this kind of evidence, few scientists believed that continents could move. Where would the energy come from to move continents? However, in the last 20 years, geologists have discovered great

amounts of evidence to support the idea that continents do move. Most scientists now believe the theory of continental drift. Let's examine the theory.

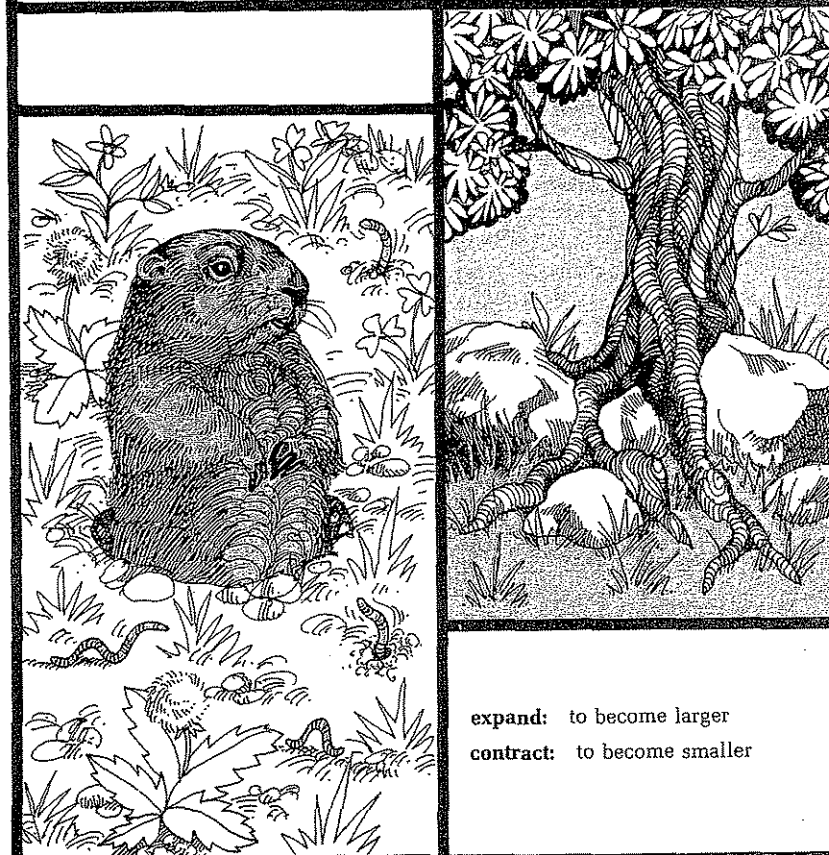
The earth's crust is solid. However, rocks deep within the earth are very hot—hot enough to be slightly soft. Stresses in the softened rock caused them to break apart into six large sections, called plates, and several small ones. Some plates include a part of a continent and part of an ocean. Other plates include mostly ocean bottom.

The earth-crust plates float on a thick layer of hot rocklike material that is quite soft. This layer is hundreds of kilometers thick. The plates move in different directions at two to ten centimeters a year. How far could one move in a million years?

Along the boundaries of the plates molten rock is often pushed up from the hot layer below. And earthquakes and volcanoes occur in the boundary areas. And where one plate pushes against another, mountains develop. For example, as the plate carrying India pushed into the plate carrying eastern Asia, the Himalaya Mountains pushed up.

WHAT CAUSES MECHANICAL WEATHERING?

11



expand: to become larger
contract: to become smaller

AIM | What causes mechanical 11 weathering?

Ants are very tiny. What can such tiny creatures do to the earth's crust? Plenty! Ants and other animals are helping to break down the earth's crust. They are a cause of **mechanical weathering**.

The four main causes of mechanical weathering are: temperature changes, frost action, root action, and animal activity.

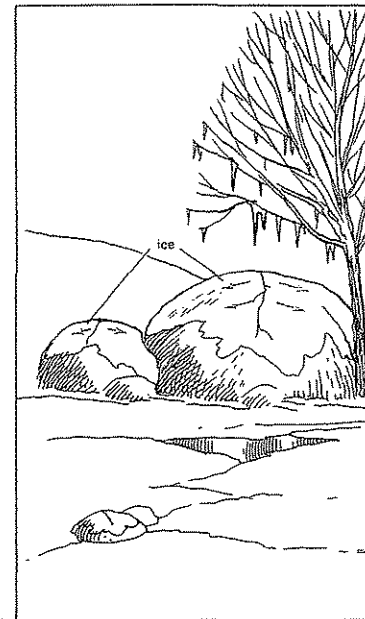
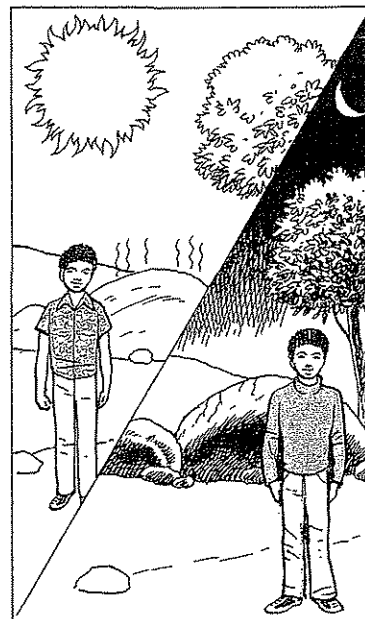
1. **Temperature changes:** Heat makes most things **expand**—grow bigger. Cold makes most things **contract**—grow smaller. In most places, it is warmer during the day than at night. Heat expands rocks during the day. At night, the rocks cool off and contract. The expanding and contracting happen over and over again. That strains the rocks. The strain makes them crack—a tiny bit at a time.

2. **Frost action:** Most things contract when they freeze. Not water! Water expands when it freezes into ice. Rain water seeps into tiny cracks in rocks. When the water freezes, it expands. The ice presses against the sides of the cracks. The pressure is great. It can make cracks bigger. It can even break apart the rocks.

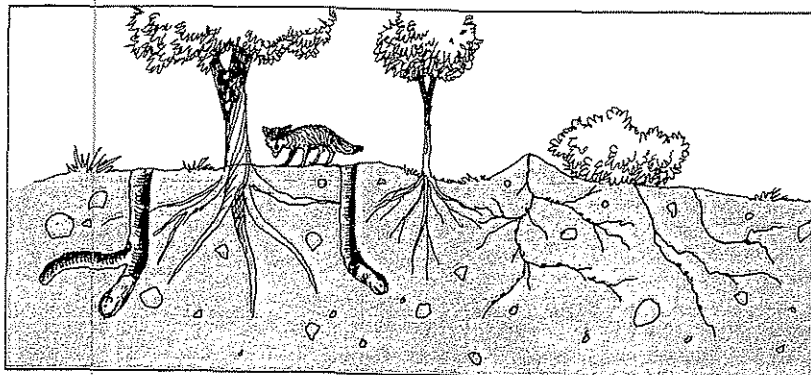
3. **Root action:** Trees and shrubs have roots that can grow into cracks of rocks. Growing roots are very strong. They can split rocks.

4. **Animal activity:** Animals do not break rocks apart by themselves. But some animals dig into the ground. Ants, worms, woodchucks, and others dig holes. The holes let in air and water. The air and water weather the rocks.

CHOOSE ONE Choose the correct word or term for each statement. Write your choice in the space.



- A. 1. During the day, rocks _____
expand, contract
2. During the night, rocks _____
expand, contract
3. Contraction and expansion strain rocks. Strain can _____ rocks.
cool, crack
4. Changes of temperature can cause _____ weathering.
chemical, mechanical
5. Water _____ seep into cracks easily.
does, does not
6. Water _____ when it freezes.
expands, contracts
7. Ice presses against the cracks in rocks. Pressure can _____ rocks.
contract, crack
8. Frost action is an example of _____ weathering.
chemical, mechanical



C. A busy world below the ground.

9. Digging into soil makes _____
animals, holes

10. Holes let in _____
pressure, air and water

11. Air and water _____
wear down rocks, keep rocks in one piece



D.

12. The rock in this picture was split by _____
roots, ice

13. Root-action is an example of _____ weathering.
mechanical, chemical

14. Mechanical weathering _____ change a rock's chemicals.
does, does not

COMPLETING SENTENCES

Complete the sentences with the choices below.

roots
more
weathering
root action
water

carry away
frost action
pressure
temperature changes
holes

mechanical
crack
animal activity
air

- The breaking down of the earth's crust into smaller and smaller pieces is called _____.
- Weathering that does not cause chemical changes is called _____ weathering.
- Four causes of mechanical weathering are _____, _____, _____, and _____.
- Heating and cooling over and over again can _____ rocks.
- When water freezes it takes up _____ room.
- The _____ of ice can split a rock.
- Ants, worms, and woodchucks help weathering because they make _____ in the soil.
- _____ and _____ pass through the holes that animals make in the soil.
- A plant's _____ can split rocks.
- Weathering just splits the earth's crust into smaller and smaller pieces. It does not _____ the pieces.

MATCHING

Match the two lists. Write the correct letter on the line next to each number.

- | | |
|------------------------------|--|
| 1. _____ weathering | a) expands rocks |
| 2. _____ water | b) contracts rocks |
| 3. _____ rise in temperature | c) breaks down the earth's crust |
| 4. _____ drop in temperature | d) the parts of a plant that are in the ground |
| 5. _____ roots | e) expands when frozen |

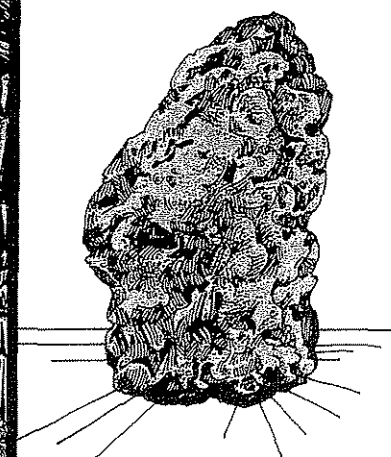
TRUE OR FALSE Write T on the line next to the number if the sentence is true.
Write F if the sentence is false.

1. _____ Mechanical weathering changes a rock's chemicals.
2. _____ "Expand" means to become larger.
3. _____ Heat makes rocks expand.
4. _____ Rocks expand at night.
5. _____ Expansion and contraction can strain rocks.
6. _____ Grass roots have no force.
7. _____ Rocks usually have tiny cracks and holes.
8. _____ Water can go into tiny openings.
9. _____ Air and water help weathering.
10. _____ Woodchucks eat rocks.

REACHING OUT Why do we say that the earthworm is "one of man's best friends"?

WHAT CAUSES CHEMICAL WEATHERING?

12



oxide: a chemical that has oxygen in it

AIM | What causes chemical 12 weathering?

Chemical weathering breaks up rocks and changes the chemicals of the rocks. A chemically weathered rock may be brittle. It may break easily. You could even break it with your hands.

Chemical weathering has worn down huge parts of the earth's crust. It happens fastest in hot climates. But "fast" chemical weathering is very slow. To dissolve just 30 meters (100 feet) of limestone takes about 6 million years.

Most chemical weathering is caused by the actions of oxygen, rain water, or carbon dioxide.

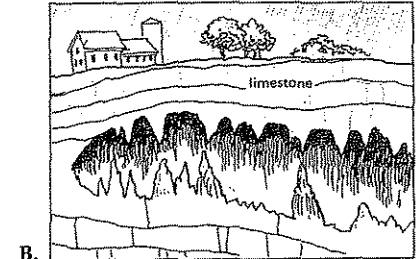
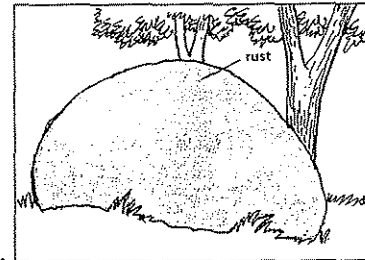
1. Oxygen in the air links up with some of the elements in rocks. The link-up forms oxides. The oxides break away from the rocks.

One oxide that you probably know well is rust. Rust is iron oxide. Iron is found in many rocks. When oxygen links up with iron, rust (iron oxide) is formed. Rust crumbles easily. Rusted rocks fall apart.

2. Rain water can change minerals in two ways. a) It dissolves some minerals. b) Water links up with other minerals. Then new substances are formed. The new substances break away from rocks. And the rocks crumble.

3. Carbon dioxide in the air dissolves easily in rain water. This forms carbonic (kar BON ik) acid. Acids dissolve limestone. Carbonic acid has dissolved underground limestone in many places. Mammoth Caves, in Kentucky, was formed by the action of carbonic acid. So was Carlsbad Caverns, in New Mexico.

CHOOSE ONE Choose the correct word or term for each statement. Write your choice in the space.



A. 1. This rock in figure A is "rusting".

a) Rust forms when _____ links up with _____.
limestone, iron oxygen, carbon dioxide

b) The iron comes from the rock. Where does the oxygen come from?

_____ the air, rain

2. The chemical name for rust is _____.
carbon oxide, iron oxide

3. What kind of weather speeds rusting? _____.
cold and dry, warm and moist

4. Rusting is an example of _____ weathering.
mechanical, chemical

Study figure B. Then answer the following questions.

5. What dissolved the limestone to form these caves? _____.
carbon dioxide, carbonic acid

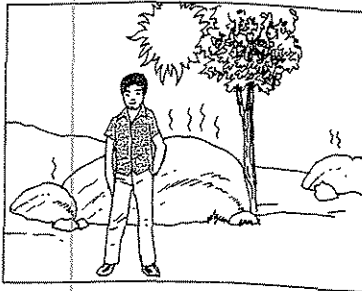
6. Carbonic acid forms when _____ links up with _____.
carbon dioxide, oxygen iron, water

7. Carbon dioxide comes from _____.
water, the air

8. The dissolving of limestone is an example of _____ weathering.
mechanical, chemical

9. Chemical weathering _____ change the chemicals in rocks.
does, does not

10. Chemical weathering _____ form new products.
does, does not



A.

MECHANICAL WEATHERING OR CHEMICAL WEATHERING?

Each diagram below shows weathering. Study each diagram. Then answer the questions next to each diagram.

1. A is an example of

_____ weathering.
mechanical, chemical

2. The chemical make-up of the crust

_____ changing.
is, is not

3. B is an example of

_____ weathering.
mechanical, chemical

4. The chemical make-up of the crust

_____ changing.
is, is not

5. C is an example of

_____ weathering.
mechanical, chemical

6. The chemical make-up of the crust

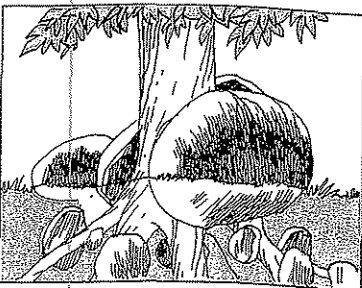
_____ changing.
is, is not

7. D is an example of

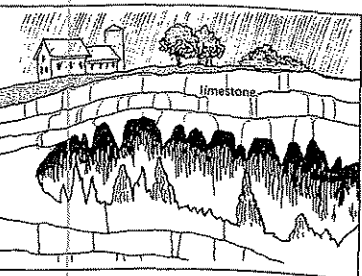
_____ weathering.
mechanical, chemical

8. The chemical make-up of the crust

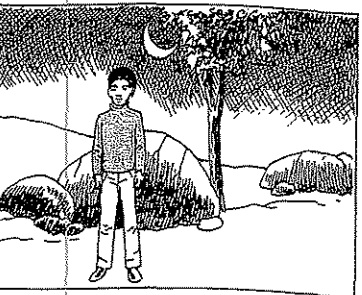
_____ changing.
is, is not



B.



C.



D.

COMPLETING SENTENCES

Complete the sentences with the choices below. Two of these answers may be used twice.

the air
oxygen
underground caves
rust

oxide
speeds
rain water

new products
crumbles
carbon dioxide

- Most chemical weathering is caused by the actions of _____, _____, and _____.
- Chemical weathering always forms _____.
- Oxygen links up with iron to form the compound called iron _____.
- Another name for iron oxide is _____.
- Rust _____ easily.
- The oxygen that rusts iron comes from _____.
- Carbonic acid is formed when _____ dissolves in water.
- Carbon dioxide comes from _____.
- Dissolved limestone may form _____.
- Hot, moist weather _____ chemical weathering.

MATCHING

Match the two lists. Write the correct letter on the line next to each number.

- | | |
|-----------------------------------|-------------------------------|
| 1. _____ rust | a) form carbonic acid |
| 2. _____ water and carbon dioxide | b) dissolves limestone |
| 3. _____ cold, dry climate | c) speeds chemical weathering |
| 4. _____ carbonic acid | d) iron oxide |
| 5. _____ warm, moist climate | e) slows chemical weathering |

TRUE OR FALSE Write T on the line next to the number if the sentence is true.
Write F if the sentence is false.

1. _____ Mechanical weathering changes the chemicals of rocks.
2. _____ Chemical weathering changes the chemicals of rocks.
3. _____ Chemical weathering happens very fast.
4. _____ All rocks contain iron.
5. _____ Oxidation makes some rocks crumble.
6. _____ Water alone can weather some rocks.
7. _____ Carbonic acid dissolves every mineral.
8. _____ Carbonic acid is made from carbon dioxide and iron.
9. _____ Carbonic acid dissolves limestone.
10. _____ Carbonic acid dissolves limestone rapidly.

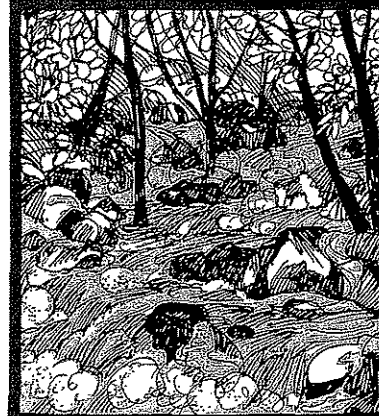
WORD SCRAMBLE Unscramble each of the following to form a word or term that you have read in this Aim.

1. ETWAR _____
2. TURS _____
3. NORI _____
4. NAIR _____
5. TONESMILE _____

REACHING OUT Look back at figure B on page 67. What may happen if too much limestone dissolves?

WHAT IS EROSION?

13



erosion: the wearing down of the earth's crust and the carrying away of the pieces

glacier: a huge moving sheet of ice

AIM | What is erosion?

13

Weathering breaks up rocks. But weathering does not carry away the pieces. What carries the pieces away?

There is another kind of wearing away. It is called erosion (ee ROE zhun). Erosion not only breaks down the crust, erosion also carries away the pieces.

There are three main forces of erosion: running water, glaciers, and wind.

- Running water is the main force of erosion. Rivers and streams change the surface of the earth. The action of running water has made more changes on the surface than any other force.

- Glaciers are huge sheets of moving ice. Some glaciers are hundreds of feet thick. Glaciers have worn away and carried away large parts of the earth's crust.

- Wind picks up and carries away small bits of sand and dust. The sand and dust bits act like sandpaper. The wind hits these bits against rocks. They wear down the rocks.

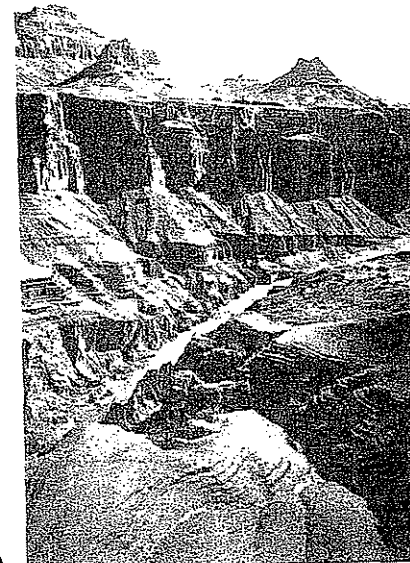
EFFECTS OF EROSION

The Grand Canyon was once flat land. The land was eroded away by the Colorado River.

In some places the canyon is 1,830 meters (6,000 feet) deep.

It took the Colorado River about 30 million years to erode so much land.

Even today, the river is slowly making the canyon deeper and wider.



A.

A glacier moves forward like a giant bulldozer. It breaks off, wears down, and carries away huge chunks of the earth's crust.



B.

Wind is moving air. The faster wind blows, the more it erodes.

Most wind erosion takes place in dry climates.



C.

THROW ONE OUT

In each of the following sets of terms, one of the terms does not belong. Underline that term.

1. glacier, gas, solid
2. air, gases, solids
3. running water, liquid, solid
4. sand, solid, gas
5. building up, wearing away, erosion

COMPLETING SENTENCES

Complete the sentences with the choices below. One of these may be used three times. Two may be used twice.

slow
erosion
running water

wind
weathering
sand and dust

fast
glaciers
moving

1. _____ wears away the earth's crust but does not carry away the pieces.
2. _____ wears away the earth's crust and also carries away the pieces.
3. The three main forces of erosion are _____, _____, and _____.
4. Most erosion is done by _____.
5. In dry places, most erosion is done by the _____.
6. In the far North and South, much erosion has been done by _____.
7. A glacier is a huge sheet of _____ ice.
8. The Grand Canyon was carved out by _____.
9. Wind erodes because it carries _____.
10. A _____ wind erodes more than a _____ wind.

MATCHING

Match the two lists. Write the correct letter on the line next to each number.

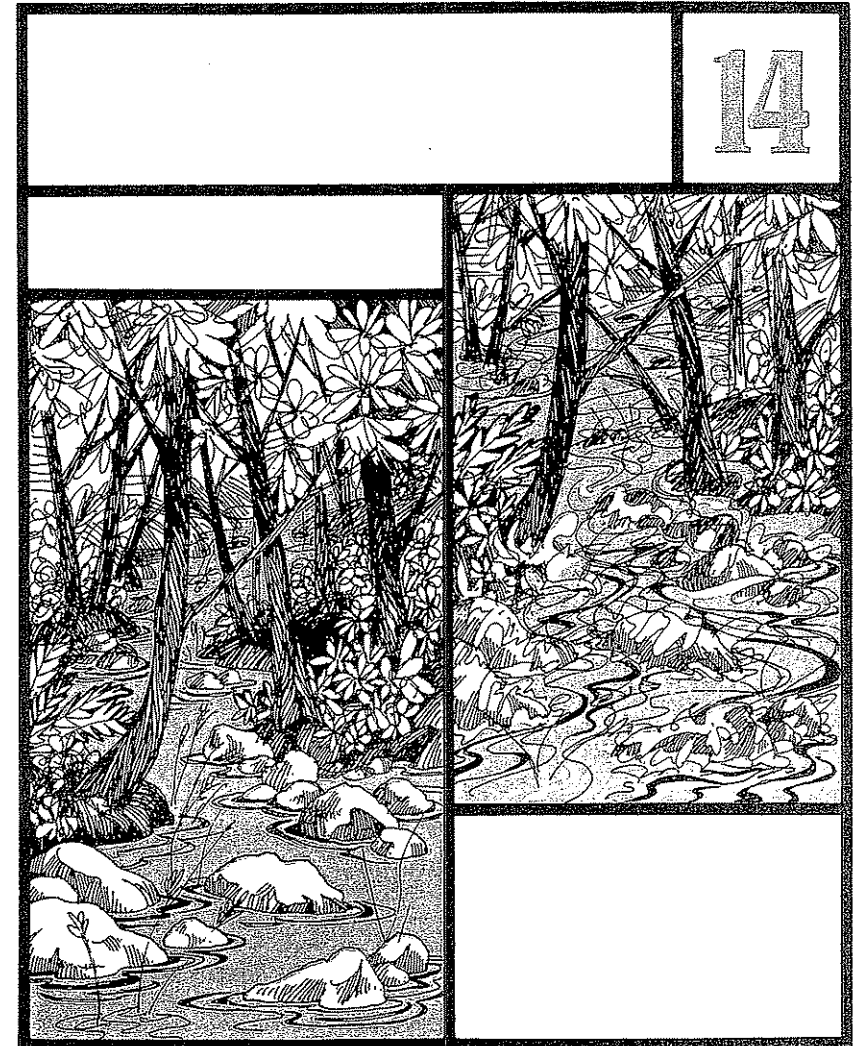
- | | |
|------------------------------|---------------------------------------|
| 1. _____ erosion | a) chief force of erosion |
| 2. _____ weathering | b) not in hot climates |
| 3. _____ moving water | c) wears away but does not carry away |
| 4. _____ wind erosion | d) wears away and also carries away |
| 5. _____ erosion by glaciers | e) mostly in dry climates |

TRUE OR FALSE Write T on the line next to the number if the sentence is true.
Write F if the sentence is false.

1. _____ Weathering wears down the earth's crust.
2. _____ Erosion wears down the earth's crust.
3. _____ Weathering carries away broken rocks.
4. _____ Erosion carries away broken rocks.
5. _____ Weathering and erosion change the way the earth looks.
6. _____ Most erosion is done by the wind.
7. _____ Most wind erosion takes place in moist climates.
8. _____ Erosion happens fast.
9. _____ Weathering helps erosion.
10. _____ Erosion helps weathering.

REACHING OUT Is erosion a mechanical or chemical process? Why?

HOW DOES RUNNING WATER ERODE THE EARTH'S SURFACE?



AIM How does running water 14 erode the earth's surface?

Moving water is very powerful. You have seen this in movies or on TV: people are in a boat. The water current is pulling them toward a waterfall. They row as hard as they can, but the water current is too strong. Usually something saves them. Otherwise, they are pulled over the falls.

We don't think about the power of moving water except when it creates danger. But moving water keeps changing streams and rivers.

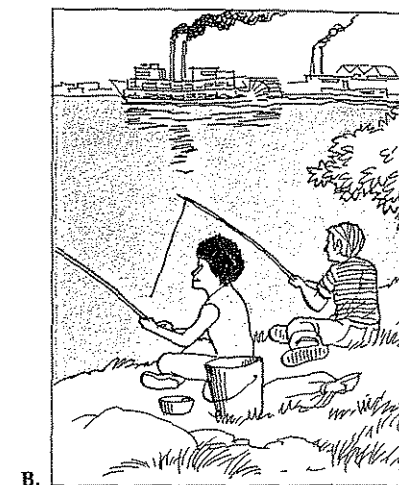
Water in rivers and streams picks up pebbles, sand, silt, and clay. It even picks up heavier things—gravel, rocks, and boulders. All these things act as abrasives. They scrape away at the bottoms and sides of streams.

Speed makes the difference. The faster a stream moves, the more it carries. The more material the stream carries, the faster the bottom and sides of the stream are eroded. Streams flow very fast when they go down steep slopes. Streams flow more slowly when they go down gentle slopes. So steep slopes are eroded faster than gentle slopes.

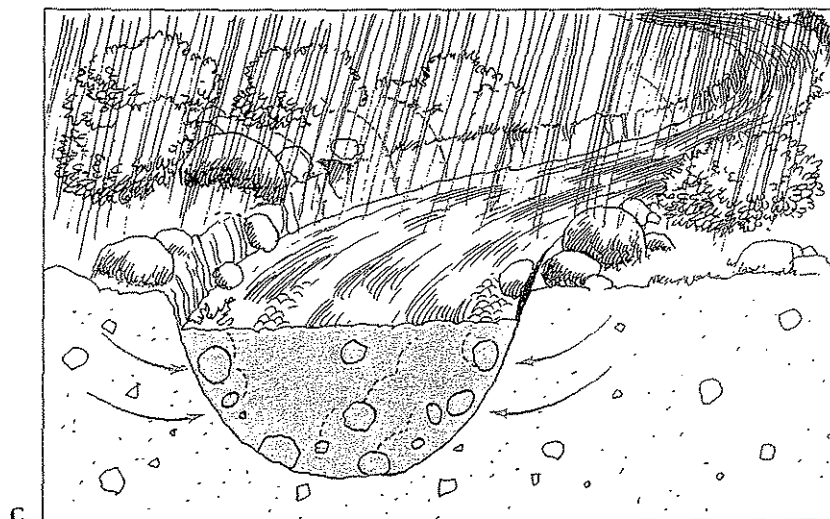
Sometimes streams carry extra water. That is because of heavy rains. The extra water makes the stream move faster. Because it is faster, the water picks up more material and causes more erosion.

Streams are the greatest force of erosion. They have worn away large parts of our earth's surface.

WHAT DO THE PICTURES SHOW?



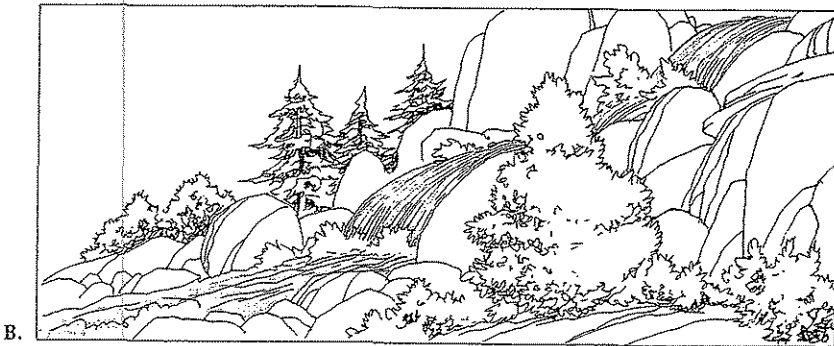
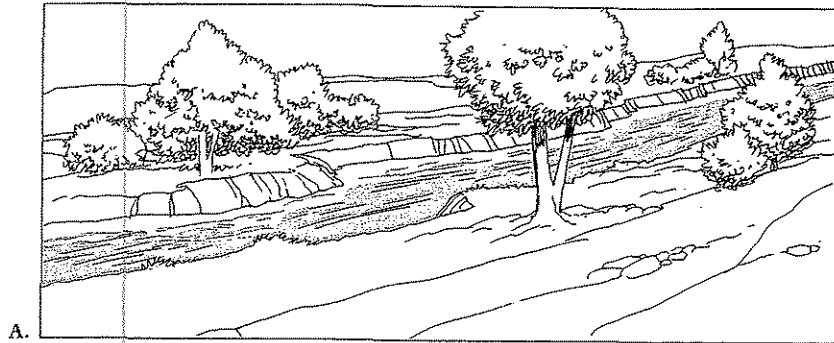
To scientists, both of these are streams.



Water enters a stream in three ways. Some rain falls directly into the stream. Some water washes off from the top of the ground. Other water seeps in from under the ground.

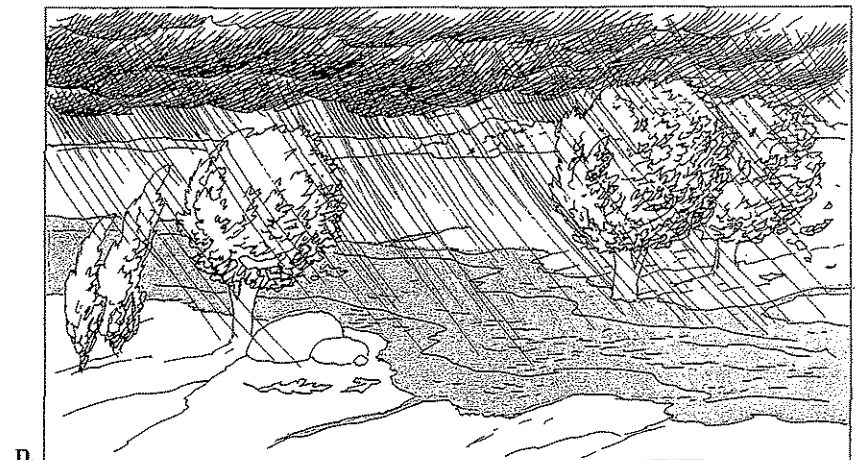
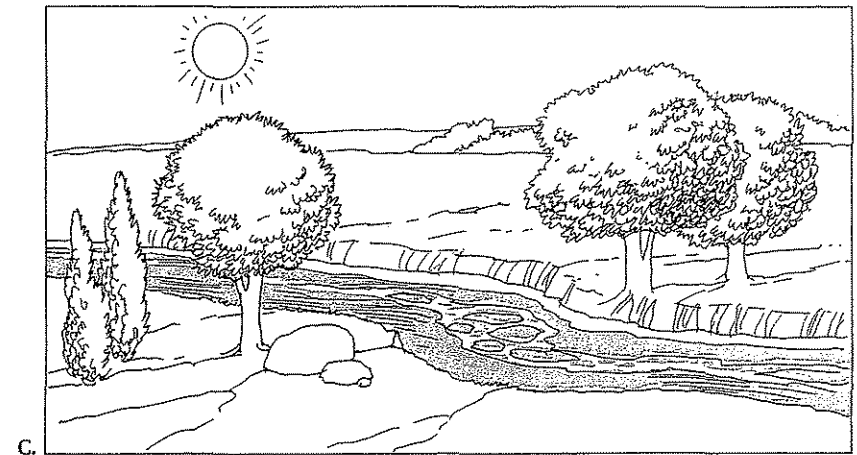
STUDYING STREAM EROSION

Study the diagrams below. Then answer the questions under each diagram.



1. Figures A and B show two different streams. Which stream ...

- a) is moving down a gentle slope? _____
- b) is moving down a steep slope? _____
- c) is moving faster? _____
- d) is moving slower? _____
- e) carries more sediment? _____
- f) carries less sediment? _____
- g) erodes more? _____
- h) erodes less? _____



2. Figures C and D show the same stream at different times. In which diagram is the stream ...

- a) carrying more water? _____
- b) carrying less water? _____
- c) carrying more sediment? _____
- d) carrying less sediment? _____
- e) eroding more? _____
- f) eroding less? _____

COMPLETING SENTENCES

Complete the sentences with the choices below. Two of these may be used twice.

wind
more
particles
carries away

erode
breaks down
downhill
moving water

faster
glaciers
less

1. Weathering only _____ the earth's crust.
2. Erosion _____ and also _____ the earth's crust.
3. The main forces of erosion are _____, _____, and _____.
4. Most erosion is done by _____.
5. Streams carry all kinds of _____.
6. Materials carried by streams _____ the sides and bottom of the stream.
7. Streams move only in a _____ direction.
8. Steep streams move _____ than gently sloping streams.
9. Steep streams carry _____ particles than gently sloping streams.
10. Gently sloping streams erode _____ than steep streams.

MATCHING

Match the two lists. Write the correct letter on the line next to each number.

- | | |
|-----------------------|--|
| 1. _____ moving water | a) fast-moving stream |
| 2. _____ river | b) most important force of erosion |
| 3. _____ erosion | c) slow-moving stream |
| 4. _____ steep slope | d) any wearing down and carrying away of the earth's crust |
| 5. _____ gentle slope | e) wide stream |

TRUE OR FALSE

Write T on the line next to the number if the sentence is true.
Write F if the sentence is false.

1. _____ In science talk, a "river" is a kind of "stream."
2. _____ Stream action is the most important force of erosion.
3. _____ All streams carry sediment.
4. _____ All streams flow at the same speed.
5. _____ A slow stream erodes faster than a fast stream.
6. _____ A steep stream flows faster than a gently sloping stream.
7. _____ A steep stream erodes less than a gently sloping stream.
8. _____ Fast streams carry more sediment than slow streams.
9. _____ Heavy rain makes streams erode faster.
10. _____ Streams get their water from rain.

WORD SCRAMBLE

Unscramble each of the following to form a word or term that you have read in this Aim.

1. SINEROO _____
2. TENDIMES _____
3. SMEART _____
4. DANS _____
5. VRELGA _____

WORD SEARCH The words in this list are hidden within the groups of letters. Try to find each word. When you find it, draw a line around the word. The spelling may go backwards or forwards in any direction: up-and-down, across, or diagonally.

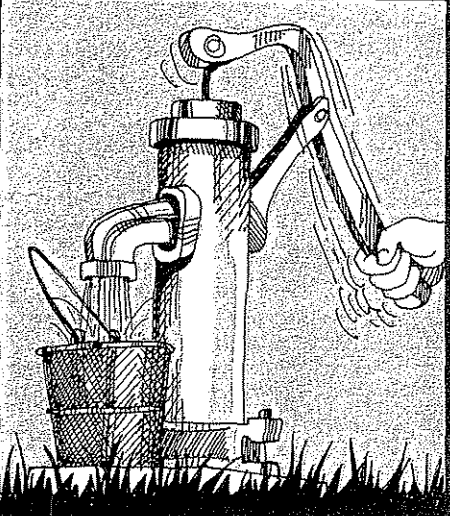
WEATHERING
CHEMICAL
MECHANICAL
FROST
ROOTS
ANIMAL
WATER
OXIDE
EROSION
GLACIER
WIND
STREAM

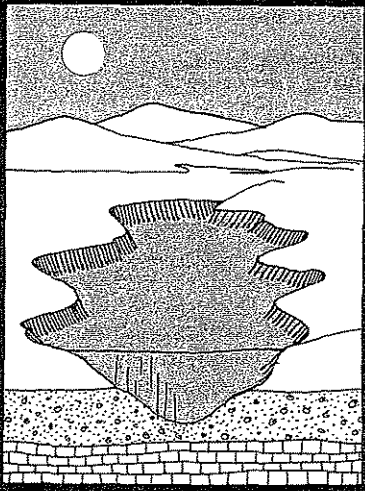
O	X	E	I	L	S	E	L	O	W	I	D	W
S	E	R	O	S	I	O	N	E	H	W	O	I
E	W	G	A	N	I	M	A	L	C	E	N	N
G	Y	C	L	S	O	T	D	S	E	A	A	T
F	L	D	H	A	H	R	E	N	D	T	M	A
R	L	O	M	E	C	H	A	N	I	C	A	L
O	I	N	R	X	M	I	N	E	X	W	E	K
S	M	I	E	O	R	I	E	E	O	A	R	N
T	N	E	T	I	O	X	C	R	L	N	T	A
G	A	N	A	X	N	T	E	A	W	E	S	R
R	E	I	W	A	L	G	S	E	L	R	H	F

WHERE DOES THE RAIN WATER GO?



15





surface water: water on the earth's crust

ground water: water below the earth's surface

water table: the highest level of ground water

AIM Where does the rain water 15 go?

It rains on all places on our earth. You have probably seen both heavy rains and light rains. Did you ever think about where the rain water goes?

You probably know part of the answer to this question. Rain falls into oceans, lakes, rivers, and streams. It becomes part of our surface water. Surface water can be seen on the surface of the earth.

But some water seeps into the ground. It is ground water—water that is under the surface of the earth. In some places, the ground water is just below the surface of the ground. In other places it is very far below the surface—hundreds of meters (thousands of feet).

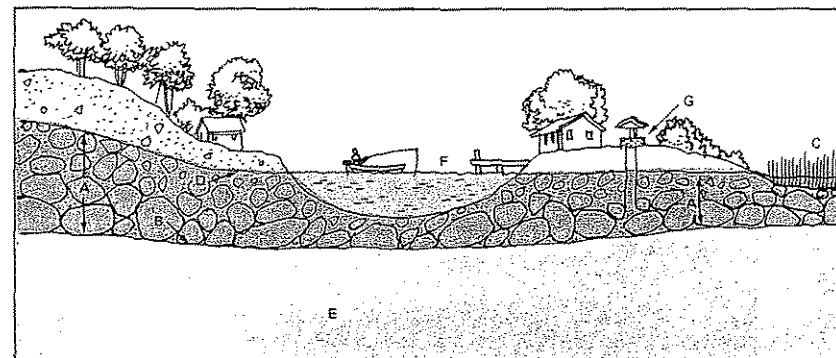
The ground water seeps into the ground until it rests on solid rock. Then it can't seep farther. The water builds up like water filling a bathtub. It gets higher and higher. The level of the top of ground water is called the water table.

The water table keeps changing. It is higher when there is lots of rain. It is lower when there is no rain—or little rain.

We don't often see ground water, but it is important. People dig wells and get drinking water from ground water. Plants get water through their roots from ground water.

Lakes may be formed from ground water. Where the land dips below the water table, a lake forms. If the land dips only slightly below the water table, a swamp forms.

THE WATER TABLE



- Identify the following by letter.
 - water table _____
 - swamp _____
 - lake _____
 - well _____
 - solid rock _____
 - solid-rock line _____
 - crust below the surface that is soaked with water _____
- Trace the water table [line] with a red pencil.
- The water table _____ a straight line.
is, is not
- A water table _____ change.
does, does not
- When there is little rain . . .
 - the water table _____
rises, lowers
 - the lake level _____
rises, lowers
 - the swamp water _____
rises, may dry out
 - the well water _____
rises, may dry out

6. When there is a lot of rain . . .
- a) the water table _____
rises, lowers
- b) the lake level _____
rises, lowers
- c) the swamp water _____
rises, may dry out
- d) the well water _____
rises, may dry out

The kind of soil a place has also affects the water table. Some places have tightly packed soil, or soil that has a lot of clay in it. Clay and tight soil hold back water. It can't seep into the ground. Usually, these places have low water tables.

Good soil has many holes in it and very little clay.

COMPLETING SENTENCES Complete the sentences with the choices below.

far below the surface
lakes
ground water
surface water
swamps

low
high
water table
amount of rainfall

always changing
near the surface
drinking water
water to plants

1. Water on the ground is called _____.
2. Water that is below the earth's surface is called _____.
3. The upper level of ground water is called the _____.
4. In some places the water table is _____. In other places it is _____.
5. _____ and _____ form in places where the land dips below the water table.
6. The water table is _____.
7. The water table is affected by the _____.

8. In dry climates, the water table is _____.
9. In wet climates, the water table is usually _____.
10. Ground water is important to man because it gives _____ and _____.

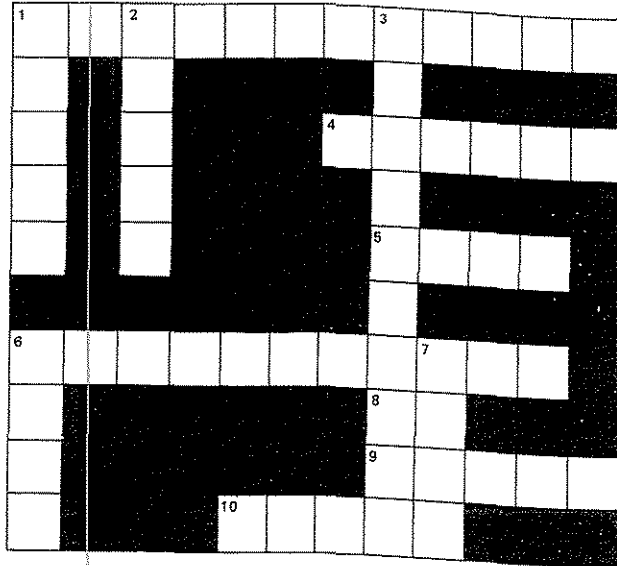
MATCHING Match the two lists. Write the correct letter on the line next to each number.

1. _____ water table a) has high water table
2. _____ swamp area b) lowers the water table
3. _____ heavy rainfall c) lakes and streams
4. _____ dry period d) upper level of ground water
5. _____ surface water e) raises the water table

TRUE OR FALSE Write T on the line next to the number if the sentence is true.
Write F if the sentence is false.

1. _____ The water table is mostly under ground.
2. _____ The water table is the same everywhere.
3. _____ The water table changes.
4. _____ During dry weather, the water table rises.
5. _____ During wet weather, the water table rises.
6. _____ Swamps are found in places that have a high water table.
7. _____ A lake can dry up.
8. _____ Much rain always means a high water table.
9. _____ Good soil has a lot of clay.
10. _____ Ground water is important only to plants.

CROSSWORD Fill in the blank spaces by following the clues across and down.
PUZZLE Use the words from the answer list.

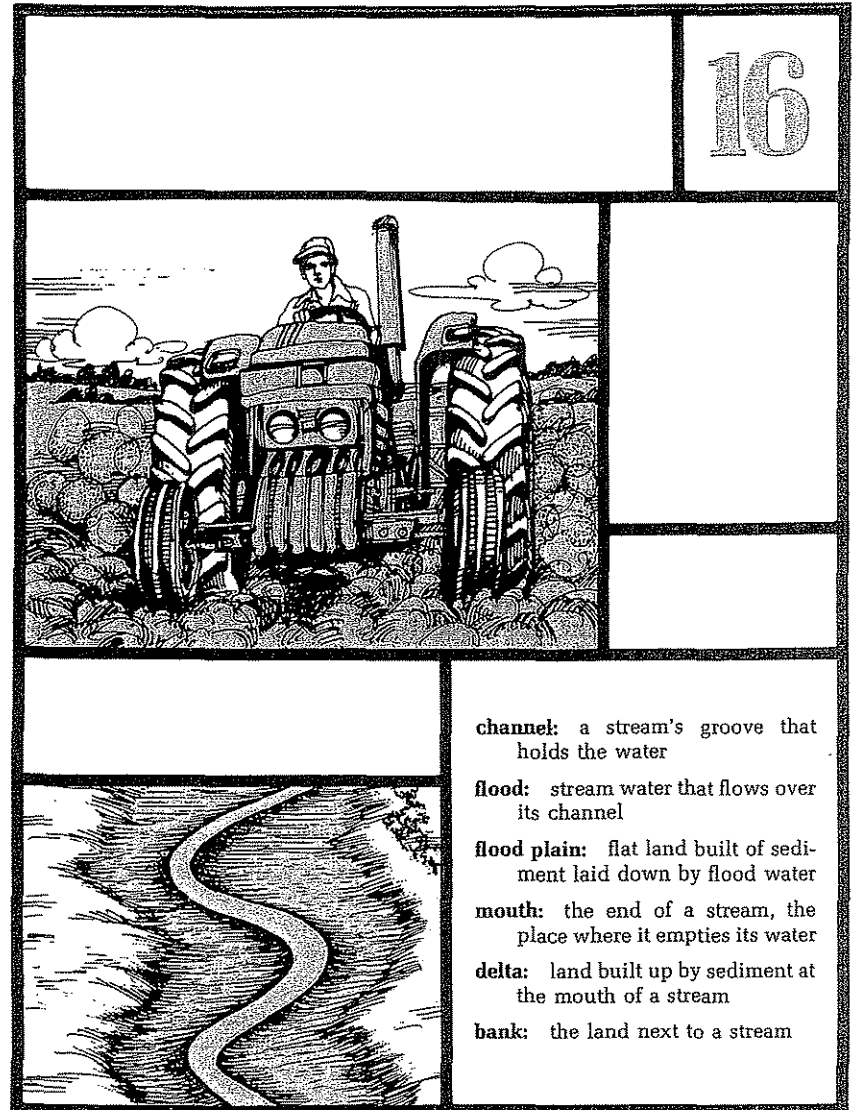


Answer List
 BE
 GOOD
 GROUND WATER
 LAKES
 LOWER
 RAIN
 RIVER
 STREAM
 SURFACE WATER
 SWAMP
 TEAR
 WATER TABLE

1. Water you can see on the surface of the earth.
4. River.
5. It falls into streams.
6. Water that is under the surface of the earth.
8. Where land dips below the water table there may _____ a lake.
9. Bodies of water surrounded by land.
10. When there is little rain, the water table is _____.
1. If the land dips a little below the water table, there is a _____.
2. Very wide stream.
3. The level of the top of ground water.
6. Ground water is _____ for plants.
7. "Raindrop" from your eye.

WHAT ARE FLOOD PLAINS AND DELTAS?

16



channel: a stream's groove that holds the water
flood: stream water that flows over its channel
flood plain: flat land built of sediment laid down by flood water
mouth: the end of a stream, the place where it empties its water
delta: land built up by sediment at the mouth of a stream
bank: the land next to a stream

AIM | What are flood plains and 16 deltas?

Running water carries sediment. But it cannot carry it forever. Sooner or later, the sediment must settle. Some streams may carry sediment very far. But at some time, the stream will deposit the sediment.

The sediment that streams deposit builds up land areas. Two kinds of land areas that are built up by sediment are flood plains and deltas.

FLOOD PLAINS After a heavy rain, a stream carries more water than usual. This raises the water level. Sometimes the level gets so high that the water flows over its channel—the place it usually flows through. Then you get flooding.

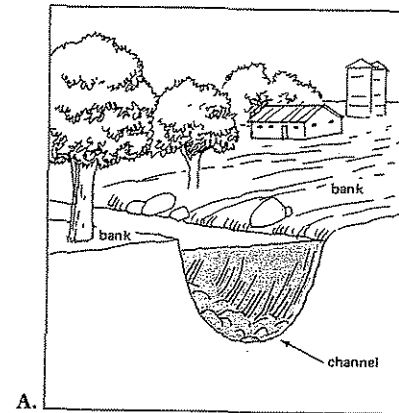
The flood water deposits fine sediment on the banks—the land next to the stream. Some streams flood often. The sediment builds up flat areas called flood plains. Soil on flood plains is very good for farming.

DELTA Every stream empties its water into a larger body of water. It empties into a larger river or an ocean. The place where a stream empties its water is called the mouth.

A stream flows slowly at the mouth. It deposits the sediment at the mouth. The sediment builds large land areas, called deltas. A delta is shaped like a triangle. It gets its name from the Greek letter "delta" (Δ).

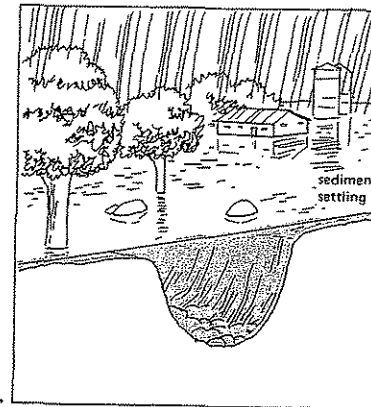
FLOOD PLAINS AND DELTAS

Usually, stream water stays in its channel. It does not flow onto its banks.



A.

In times of heavy rain, however, the water may flow over its channel.



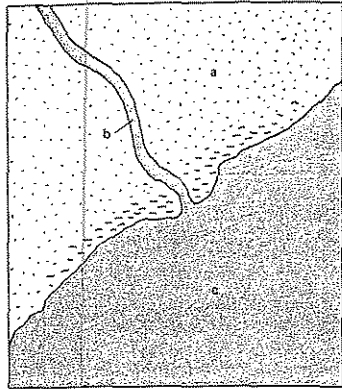
B.

Flood water deposits fine sediment on both banks of a stream. The sediment builds flood plains.

Flood plain soil is very fertile. There are many good farms on flood plains. *BUT* the farmers are taking a big chance. Why? _____

Would you want to live on a flood plain? _____

Explain why or why not. _____



C.

HOW A DELTA GROWS

Imagine yourself looking down from high in the sky.

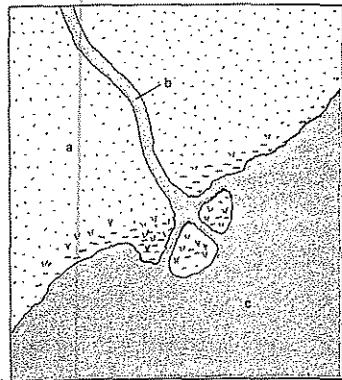
"a" is land

"b" is a stream

"c" is a large body of water.

The stream empties into the water.

The stream deposits its sediment at its mouth. The sediment builds up. All the sediment is under water.

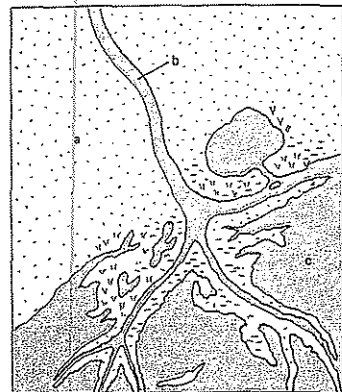


D.

The sediment builds up and up. Much of it reaches above the water level. Much is now even with the land. The sediment is now "new" land.

The stream has cut new channels across this new land.

1. How many new channels do you see? _____



E.

The build-up continues. More sediment is deposited. More land builds up. The land grows outward in the shape of a delta (Δ). It will continue to grow.

2. Why will the delta keep growing?

COMPLETING SENTENCES

Complete the sentences with the choices below. One is used twice.

deposited
calmly
flood plains
channel

deltas
flooding
delta

erosion
mouth
streams

1. The wearing down and moving away of parts of the earth's crust is called _____.
2. Material that is eroded must also be _____.
3. Most eroded material is carried by _____.
4. The part of a stream that the water flows through is called the _____.
5. Stream sediment builds land areas called _____ and _____.
6. When water overflows its channel, _____ takes place.
7. Fine sediment laid down during floods builds _____.
8. The place where a stream empties its water is called its _____.
9. The water at the mouth of a stream usually flows _____.
10. Sediment deposited at the mouth of a stream builds a _____.

MATCHING

Match the two lists. Write the correct letter on the line next to each number.

- | | |
|----------------------|-----------------------------|
| 1. _____ flood plain | a) shape of a delta |
| 2. _____ delta | b) built by flood sediment |
| 3. _____ channel | c) built at mouth of stream |
| 4. _____ triangle | d) stream's end |
| 5. _____ mouth | e) carries a stream's water |

TRUE OR FALSE Write T on the line next to the number if the sentence is true.
Write F if the sentence is false.

1. _____ To a scientist, a river is a kind of stream.
2. _____ All streams carry sediment.
3. _____ The slower a stream moves, the more sediment it carries.
4. _____ A stream deposits its sediment when it speeds up.
5. _____ Flood plains build up at the mouths of streams.
6. _____ A river bank is at the end of a river.
7. _____ Heavy sediment settles before fine sediment.
8. _____ A delta keeps growing.
9. _____ Heavy rain always causes flooding.
10. _____ When water overflows its channel it moves faster.

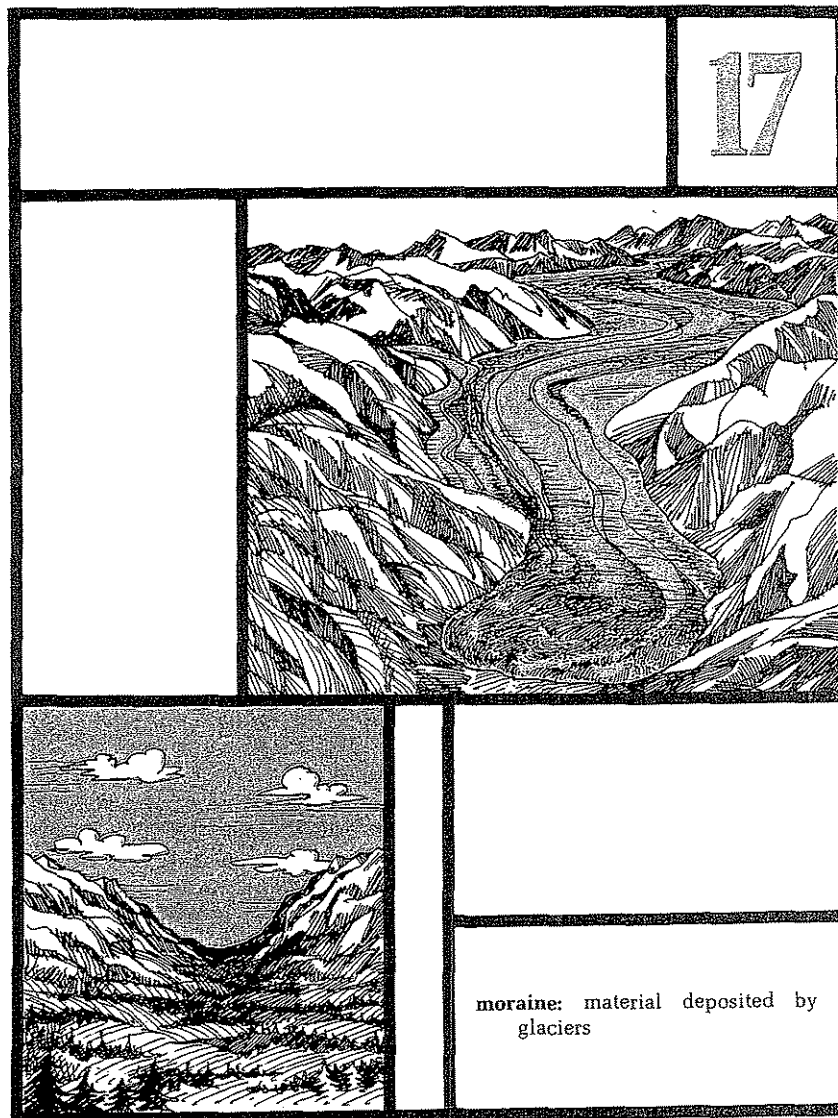
FILL IN THE VOWELS

Each of the following words has been written with its vowels missing. The vowels are A E I O U. Each is a word that you have read in this Aim. Fill in the vowels to complete each word. Before you start, guess which vowel will appear most. See if you are right.

1. SDMNT _____
2. FLD PLN _____
3. DLT _____
4. TRNGL _____
5. MTH _____

HOW DO GLACIERS CHANGE THE EARTH'S SURFACE?

17



moraine: material deposited by glaciers

AIM | How do glaciers change the 17 | earth's surface?

In some places, it is always very cold. On very high mountains and in both of the polar regions, it never rains. It only snows. And the snow never melts. It piles up and up. It becomes higher and higher. It changes to ice. And the ice layer gets very thick.

When it gets very, very thick, its weight makes it move. Slowly, it creeps forward. We call a giant sheet of moving ice a *glacier*. Glaciers erode the earth.

Glaciers have changed the shape of large parts of the earth. They still make changes. They break off large parts of the crust and carry them away. They make valleys wider and deeper. Glaciers wear down mountains and change their shapes.

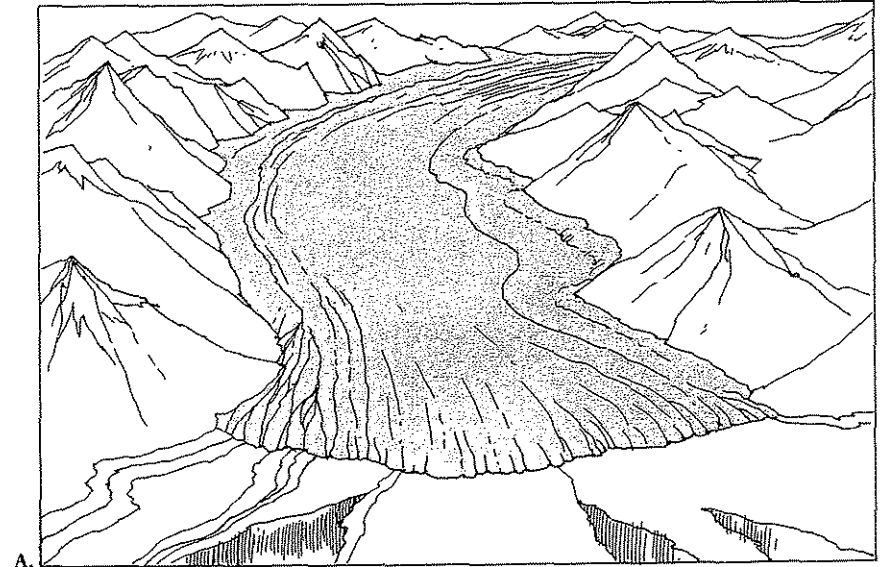
Glaciers pick up rock material as its ice flows down the rocky valleys. This rocky material is sand, rock flour, and rocks. They are all known as *TILL*. The till acts as abrasives. They wear down, or erode, other rocks on the floor and sides of the valleys.

Glaciers erode. But they also build. When they reach warm places, they melt. Then they drop the load of till they have been carrying. The till piles up as mounds and ridges, which are called *MORAINES* (muh RAINZ). If you dig in a moraine, you find the sand, rock flour, gravel, and large rocks all mixed up together. They are not sorted out in different layers. A river drops its load in layers, but not a glacier.

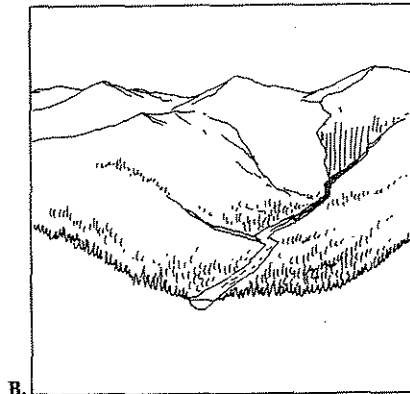
Many huge glaciers have come and then melted in the past million years. Parts of the United States were covered by glaciers. The last glacier in the United States outside of Alaska melted about 11,000 years ago. There are still some glaciers, though, in Alaska.

Scientists think that some day the glaciers will grow again. But that will be a long time from now.

EFFECTS OF GLACIERS

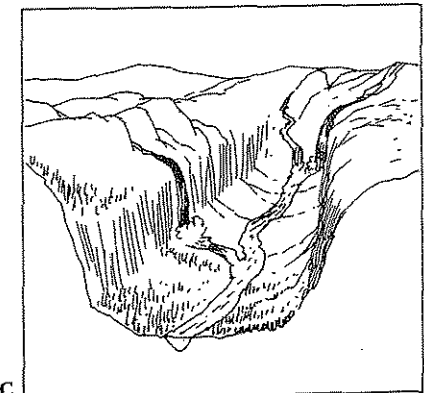


A. This glacier is moving along a valley. It is making the valley wider and deeper.



B. A valley before glacial erosion.

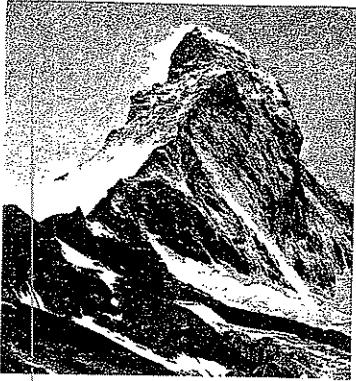
Are there streams? _____
Are there waterfalls? _____



C. The same valley after glacial erosion.

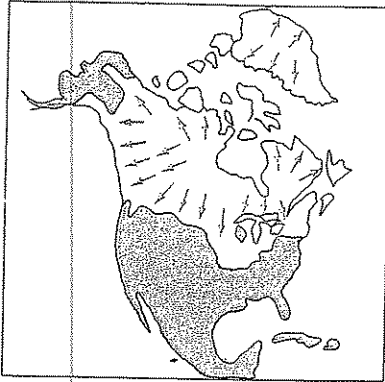
Are there streams? _____
Are there waterfalls? _____

D.



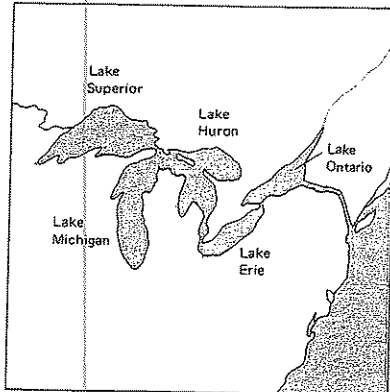
This mountain was not always this shape. Large parts of the mountain were ripped off by the force of the glacier.

E.



North America during the last Ice Age The white area shows the places that were glacier-covered. The arrows show the direction the glaciers moved.

F.



Parts of the basins of the Great Lakes were dug out by a glacier.

Water from the melted glacier filled the basins.

COMPLETING SENTENCES

Complete the sentences with the choices below.

ice	the United States	rub
boulders	slowly	carry off
moraine	rocks	widen
dust	snow	thousands
pressure of its weight	deepen	pebbles
break away		

- Glaciers start out as _____. Then they harden to _____.
- A glacier may be _____ of meters thick.
- A glacier moves because of the _____.
- Glaciers move very _____.
- Glaciers _____ and _____ big chunks of the earth's crust.
- Examples of material carried by glaciers are _____, _____, _____, and _____.
- Fragments carried by glaciers _____ against rocks underneath them.
- Material laid down by glaciers is called _____.
- Glaciers _____ and _____ valleys.
- Parts of _____ once was covered by glaciers.

MATCHING

Match the two lists. Write the correct letter on the line next to each number.

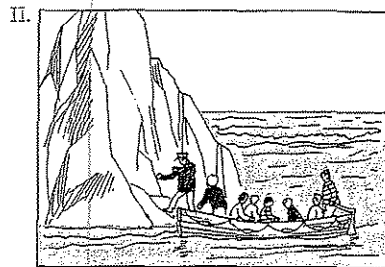
- | | |
|-------------------------------------|---|
| 1. _____ glacier | a) makes a glacier move |
| 2. _____ pressure of its own weight | b) made wider and deeper by glaciers |
| 3. _____ moraine | c) last glacier melted in United States |
| 4. _____ valleys | d) giant sheet of moving ice |
| 5. _____ about 11,000 years ago | e) fragments laid down by glaciers |

TRUE OR FALSE Write T on the line next to the number if the sentence is true.
Write F if the sentence is false.

1. _____ Snow pressed together can change to ice.
2. _____ A glacier moves by itself.
3. _____ Glaciers are small.
4. _____ A glacier is very powerful.
5. _____ Glaciers carry only small rock fragments.
6. _____ Glaciers only erode.
7. _____ Glaciers build mountains.
8. _____ Dust particles are part of moraine.
9. _____ Glaciers can carry moraine thousands of miles.
10. _____ There has been only one period of glaciers.

REACHING OUT

- I. Large parts of the Far North and South are covered with ice and snow. What would happen if all this snow and ice would melt? _____



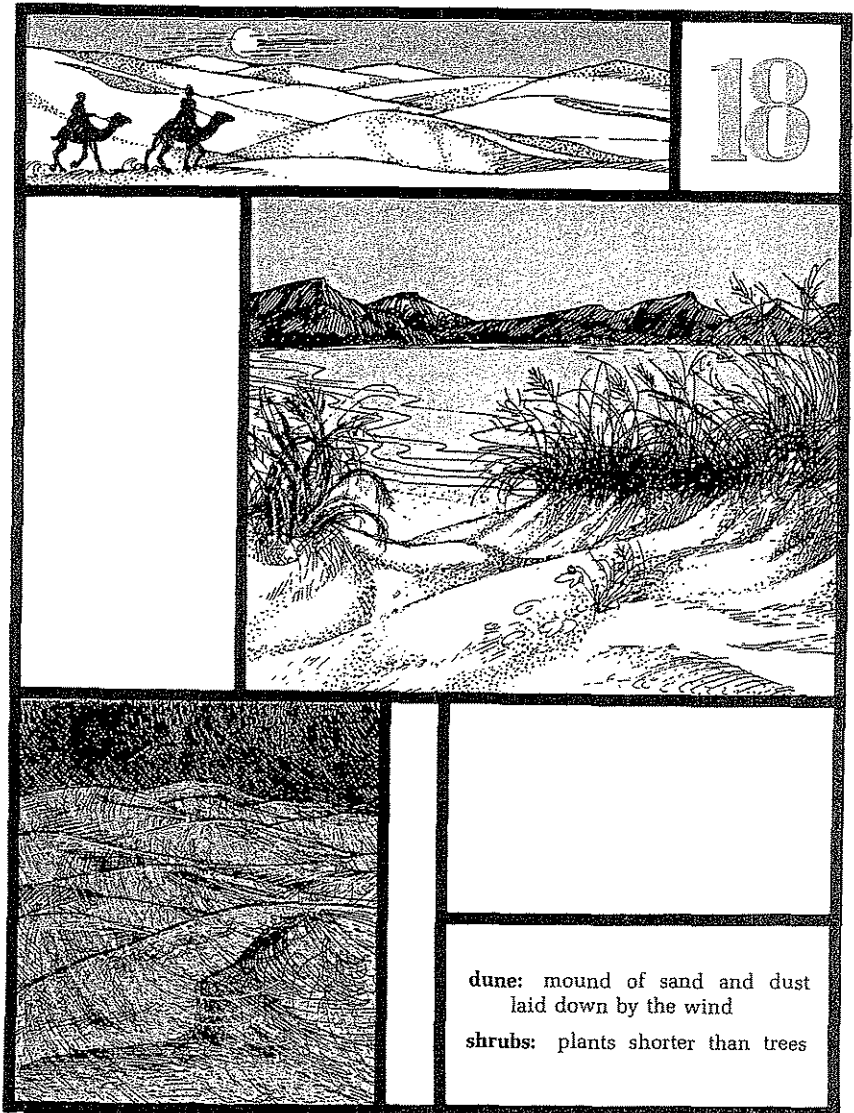
An iceberg is a huge broken-off piece of a glacier floating in the ocean.

Everyone knows that the ocean is salty. And no one should drink salt water.

Now imagine this . . . You are on an iceberg, and you need water to drink.

1. Would you melt part of the iceberg to get this water? _____
yes, no
2. Explain your answer. _____

HOW DOES WIND CHANGE THE EARTH'S SURFACE?



AIM | How does wind change the 18 | earth's surface?

Wind is moving air. It can pick up loose material and carry it far away. Did the wind ever blow your hat away? Did you ever drop your notebook on a windy day? How many important pages did you lose?

Wind is an important force of erosion in dry places. Wind itself does not erode much. Most "wind" erosion is done by particles carried by wind. This is how it happens:

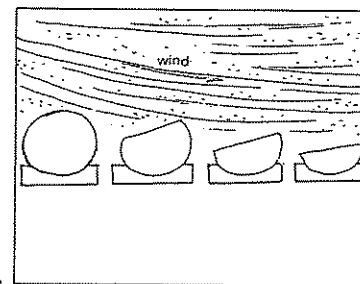
The roots of plants help to hold down soil and other particles found on the ground. Dry places have very few plants. Because of this, there is a lot of loose sand and dust on the ground. Winds pick up these particles and carry them away. The sand and dust are abrasives. They hit against rocks and grind them like sandpaper. This happens over and over again. Little by little, the rocks wear down.

The particles carried by wind erode. They also build. What is worn away in one place settles somewhere else.

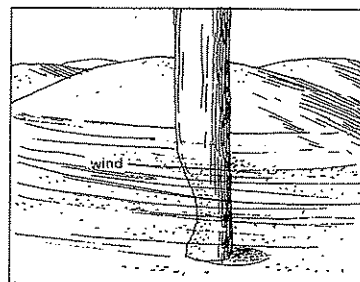
When wind slows down, it drops the material it was carrying. The material that settles builds up mounds called dunes. Dunes can cause great damage. They can bury farms and homes—even whole towns.

The government plants grasses and shrubs to try to stop wind erosion.

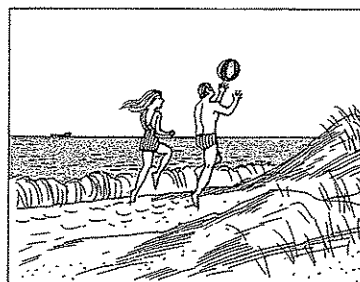
WIND EROSION



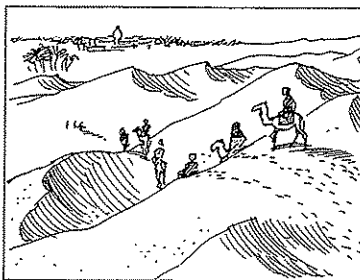
A.



B.



C.



D.

Wind erosion wears pebbles and rocks into sharp, flat forms.

These figures show the stages of erosion. The sand carried by the wind wears down the rocks little by little.

Most wind erosion takes place only a few feet off the ground.

In time, what will happen to this pole? _____

Sand dunes come in many sizes.

Some dunes are only a meter high. Others are hundreds of meters high and many kilometers long.

The Sahara Desert has gigantic dunes.

COMPLETING SENTENCES Complete the sentences with the choices below.

dust storms
build
plants
dust
dunes

sand
deposited
sand storms
damage

roots
wind
planting grasses and
shrubs

1. The most important force of erosion in dry places is the _____.
2. Dry areas usually have few _____ to hold ground material together.
3. Winds pick up and carry light-weight materials like _____ and _____.
4. In dry places, heavy winds cause _____ and _____.
5. Winds not only wear away, they also _____.
6. Material eroded in one place is _____ somewhere else.
7. Winds deposit sand and dust in mounds called _____.
8. Dunes can cause much _____.
9. Wind erosion is sometimes controlled by _____.
10. The _____ of grasses and shrubs help hold soil together.

MATCHING Match the two lists. Write the correct letter on the line next to each number.

- | | |
|------------------------|---|
| 1. _____ wind | a) carried by wind |
| 2. _____ dunes | b) follows erosion |
| 3. _____ sand and dust | c) help control wind erosion |
| 4. _____ plants | d) a force of erosion in dry places |
| 5. _____ building up | e) built by particles laid down by wind |

TRUE OR FALSE Write T on the line next to the number if the sentence is true. Write F if the sentence is false.

1. _____ Wind only erodes.
2. _____ Wind is a force of erosion only in dry places. (Careful, this one is tricky).
3. _____ Deserts are found in dry places.
4. _____ All eroded material must be deposited.
5. _____ Dunes are made of large rocks.
6. _____ Wind can move dunes from place to place.
7. _____ Dunes are found *only* in deserts.
8. _____ Roots help keep soil together.
9. _____ There are many plants in the desert.



REACHING OUT 1. Plant roots help hold soil together. How can shrub and tree branches also help hold soil together?

1. _____

2. _____

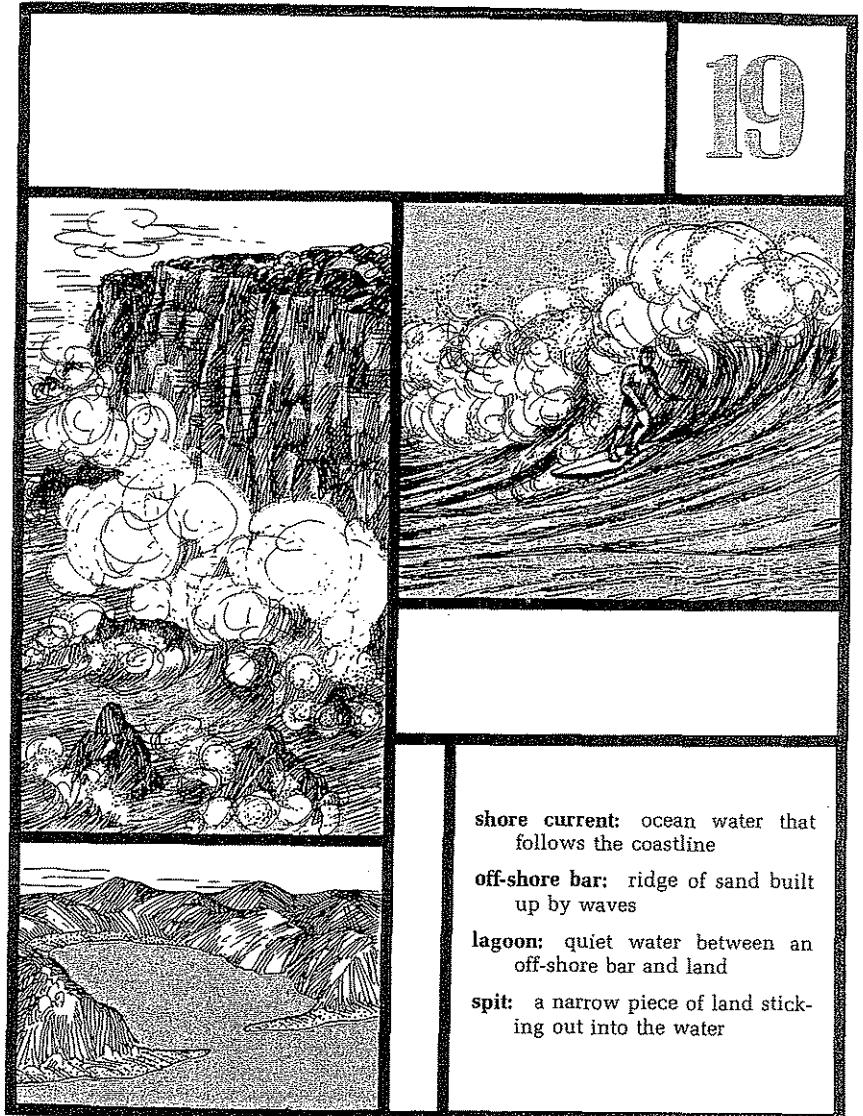
WORD SEARCH The words in this list are hidden within the groups of letters. Try to find each word. When you find it, draw a line around the word. The spelling may go backwards or forwards in any direction: up-and-down, across, or diagonally.

RAIN
WATER TABLE
GROUND WATER
SWAMP
FLOOD
DELTA
CHANNEL
MORaine
GLACIER
WIND
DUNE

M	P	D	G	A	R	Y	L	E	S	G	R	J
I	R	O	P	A	T	F	L	O	P	E	D	E
L	E	E	L	B	A	T	R	E	T	A	W	R
L	L	T	A	O	M	O	R	A	I	N	E	R
Y	I	E	N	A	W	S	W	A	M	P	R	Y
F	E	A	T	L	E	D	A	T	A	E	D	N
O	L	M	D	U	N	E	D	N	I	W	O	E
R	N	O	T	U	D	I	O	C	H	A	N	L
A	G	I	O	N	S	W	A	M	I	Q	A	E
N	O	R	E	D	P	L	G	R	S	E	Y	H
E	G	D	A	L	G	L	E	N	N	A	H	C

HOW DO WAVES CHANGE THE EARTH'S SURFACE?

19



shore current: ocean water that follows the coastline

off-shore bar: ridge of sand built up by waves

lagoon: quiet water between an off-shore bar and land

spit: a narrow piece of land sticking out into the water

AIM | How do waves change the 19 | earth's surface?

Have you ever gone swimming in an ocean? If you have been in the ocean, you probably remember the waves. A wave can knock you down.

The waves in the ocean are very powerful. If you were the strongest person on earth, waves could knock you down. Even small waves can be very strong—stronger than they look.

Most waves are caused by the wind rubbing against the water. The stronger the wind, the larger the waves.

Waves change the shoreline. Day and night, waves pound against the shore. Little by little, they erode the shoreline. The waves pick up fragments. These fragments are abrasives. They grind away and cut into the shoreline.

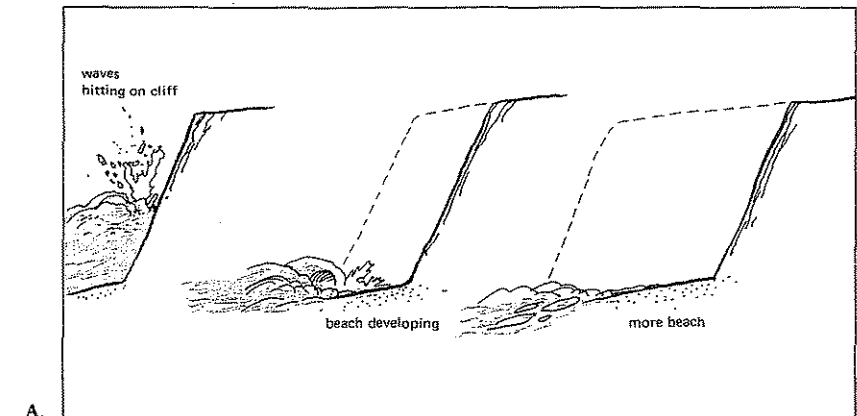
As you have probably guessed, waves not only erode, they also build. What is eroded in one place is deposited somewhere else.

Waves move in from the ocean to the shore. But some ocean water moves along the shore. The water that follows the shoreline is called a shore current.

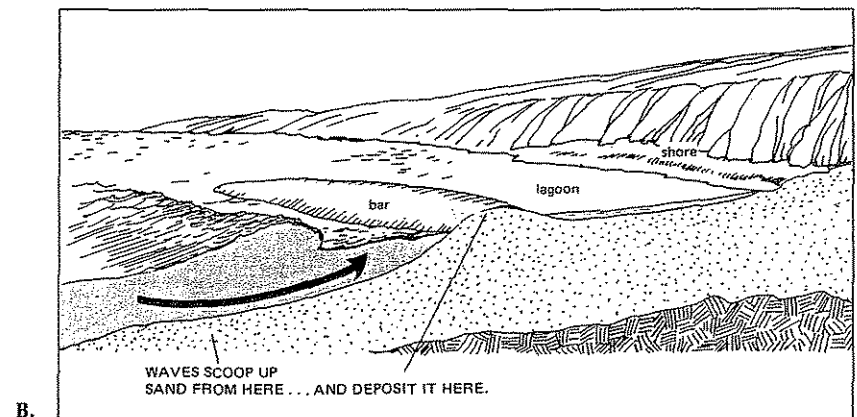
Shore currents also erode the shoreline. And shore currents also build up parts of the shoreline.

Waves and shore currents are always changing the shore lines. They are always eroding some places and building others.

BUILDING ACTIONS BY WAVES



Beaches are built of material eroded by waves and deposited on the shore.



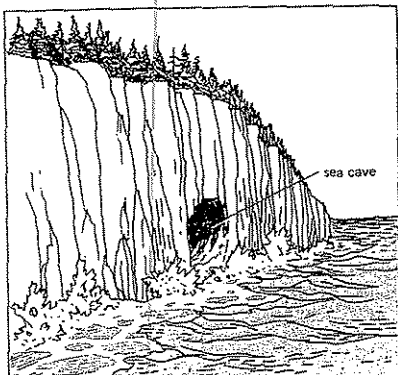
Waves scoop up sand from the ocean floor. This sand settles and builds up. It forms low ridges called *off-shore bars*.

Off-shore bars are mostly under water and not far from shore.

Off-shore bars slow down waves. The water between an off-shore bar and the shore usually is quiet.

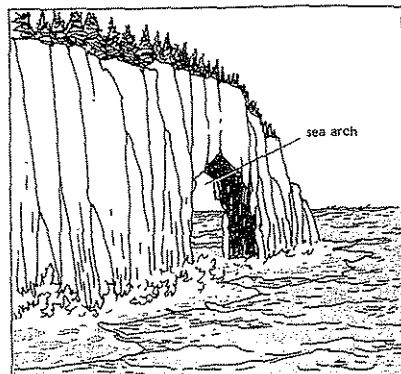
The quiet water between an off-shore bar and the shore is called a *lagoon*.

WEARING-AWAY ACTIONS BY WAVES



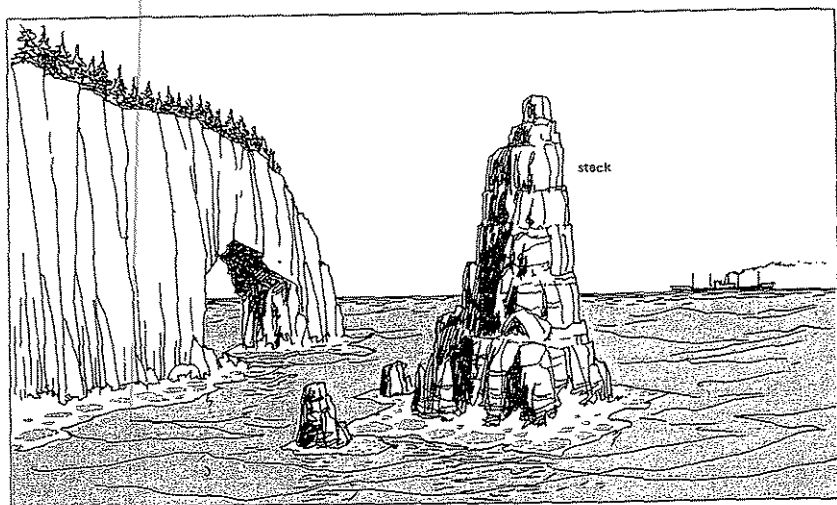
C.

Waves pound against cliffs. They carve out sea caves.



D.

Sometimes a sea cave is worn away all the way through the cliff. This "hole" in a cliff forms a sea arch.

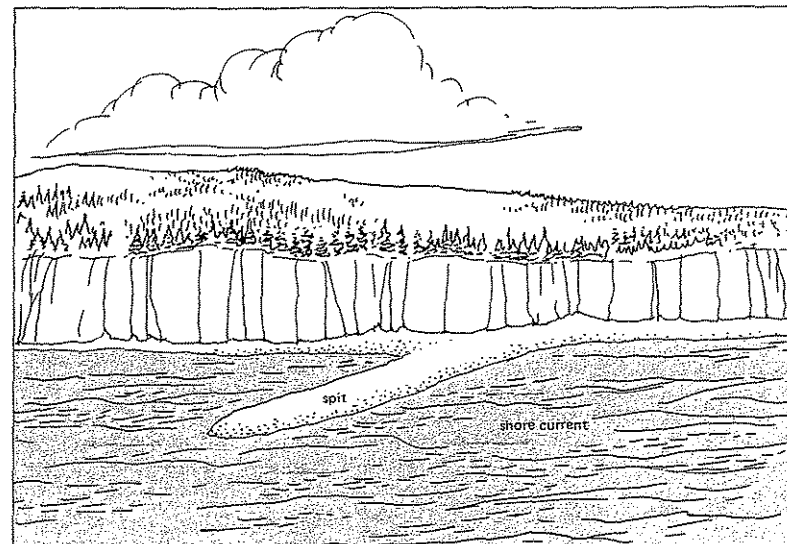


E.

Wave erosion may break away big chunks of the land.

These separated parts become small rock islands called stacks.

THE WORK OF SHORE CURRENTS



F.

Shore currents erode beaches. Sand and pebbles are carried away. Then they are deposited. The particles build up finger-like pieces of land called spits.

One end of a spit is connected to the land. The other end reaches out to the ocean.

WORD SCRAMBLE Unscramble each of the following to form a word or term that you have read in this Aim.

1. SWEAV _____
2. KACST _____
3. TIPS _____
4. GOLNOA _____
5. STRUNREC _____

COMPLETING SENTENCES Complete the sentences with the choices below.

towards
off-shore bars
wind
beaches

along
stack
sea arch

lagoon
spits
sea cave

1. Most waves are caused by _____.
2. Waves can carve out a part of a cliff and form a _____.
3. A sea cave that wears through a cliff is called a _____.
4. A chunk of land broken away from the shore by waves is called a _____.
5. Waves move _____ the shore.
6. Shore currents move _____ the shore.
7. Sediment laid down by waves on shore build _____.
8. Waves build ridges of sand called _____.
9. Shore currents build _____.
10. The quiet water between a bar and the shore is called a _____.

MATCHING Match the two lists. Write the correct letter on the line next to each number.

- | | |
|-------------------------|--|
| 1. _____ lagoon | a) caused by wind |
| 2. _____ waves | b) built by waves |
| 3. _____ shore currents | c) quiet water between the shore and bar |
| 4. _____ beaches | d) built by shore currents |
| 5. _____ spit | e) move along the shore |

WHICH CAME FIRST?

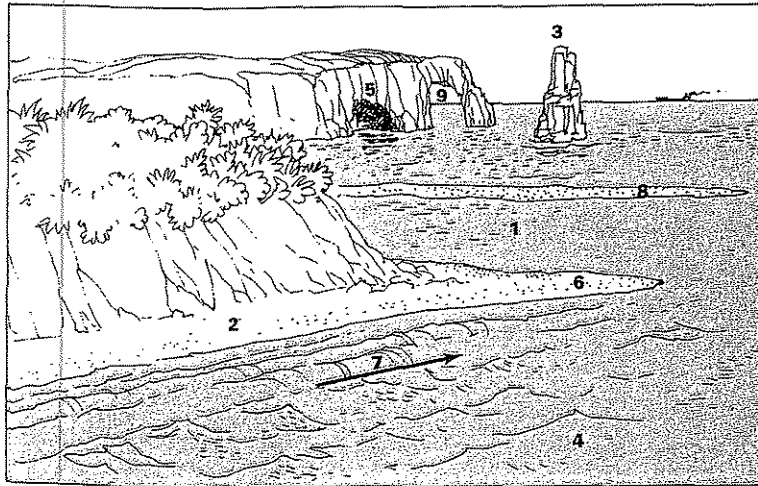
In each of the pairs below, one of the things came before the other. On the line next to each pair, write the name of the thing that came before the other.

1. rocks or sand? _____
2. sea arch or sea cave? _____
3. wind or waves? _____
4. spit or sand? _____
5. beaches or waves? _____

TRUE OR FALSE

Write T on the line next to the number if the sentence is true.
Write F if the sentence is false.

1. _____ Waves only erode.
2. _____ Shore currents only erode.
3. _____ Shore currents follow the shoreline.
4. _____ Waves follow the shoreline.
5. _____ Beaches are built from material eroded by waves.
6. _____ Sea arches are carved by waves.
7. _____ Off-shore bars are built by shore currents.
8. _____ A lagoon is a body of land.
9. _____ Water in a lagoon is very choppy.
10. _____ Most waves are caused by wind.



WHAT DOES THE PICTURE SHOW?

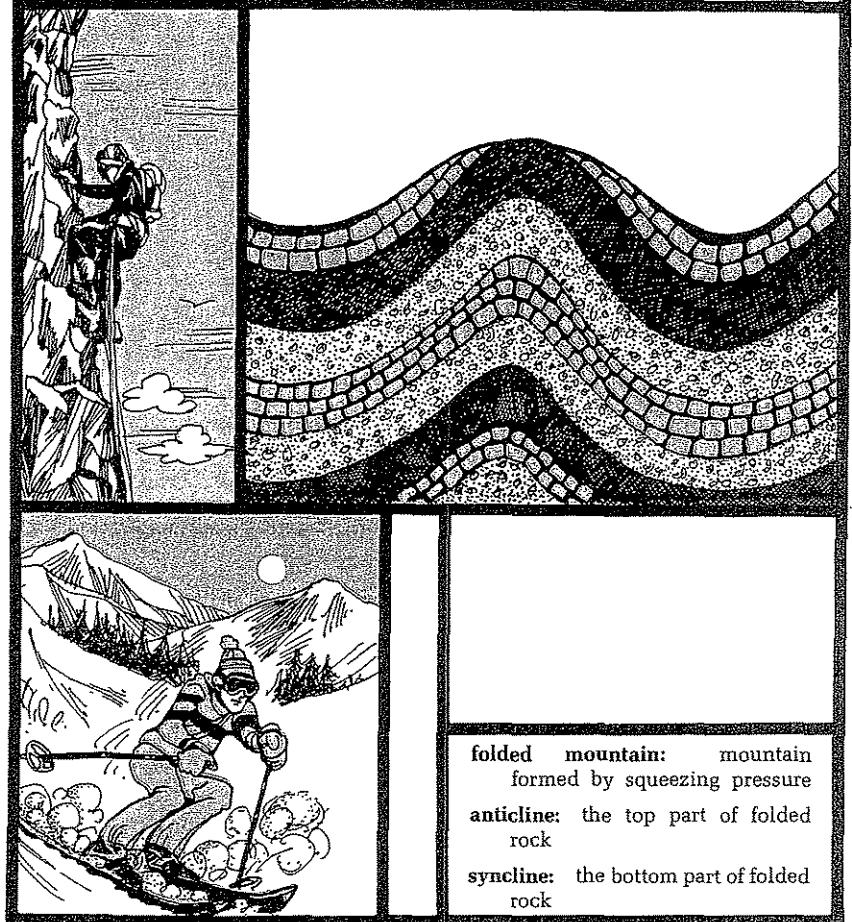
Name the features shown above. Search back in the Aim if necessary.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____

REACHING OUT Most waves are caused by wind. What else causes waves?

HOW ARE FOLDED MOUNTAINS FORMED?

20



folded mountain: mountain formed by squeezing pressure
anticline: the top part of folded rock
syncline: the bottom part of folded rock

AIM | How are folded mountains 20 formed?

Everybody knows what a mountain is. It is a section of land that is much higher than the land around it.

Mountains can be beautiful to see. Some mountains are very high, with snow-capped peaks. Such mountains are usually rocky and have sharp, jagged edges. Other mountains are lower. They are more rounded and are covered with trees. Did you ever wonder why there are different kinds of mountains? Or, how mountains are formed?

There are four different kinds of mountains:

- folded mountains;
- block mountains;
- volcanic mountains; and
- domed mountains.

Folded mountains are caused by great heat and pressure deep inside the earth's crust. Usually, you think of rock as being very hard and brittle. You probably can't imagine bending, or "folding," a rock. However, over very long periods of time (millions of years), pressure can cause thick layers of sedimentary rock to buckle and fold.

Layers of folded rock look something like waves. They have *upfolds* and *downfolds*. An upfold is called an *anticline* (AN tee kline). A downfold is called a *sincline* (SIN kline). Folded mountains are anticlines that rise high above the land around them.

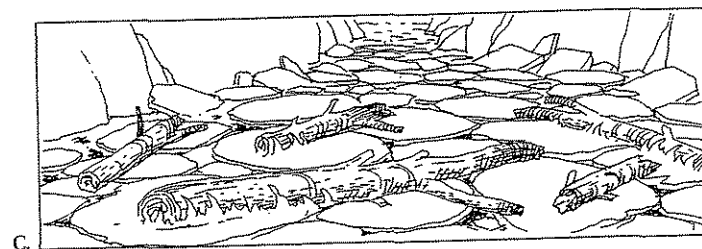
Scientists are not sure what causes the pressures that make folded mountains. There are several theories. The most recent theory is called the *Plate Theory*.

THE PLATE THEORY AND FOLDED MOUNTAINS

Most scientists believe that folded mountains can be explained by the Plate Theory. According to this theory:

1. The earth's crust and upper mantle are made up of several plates.
2. The continents and ocean floors are part of these plates.
3. The plates are moving. They move very, very s-l-o-w-l-y (about 1 centimeter per year).

To help you understand the plate theory, imagine huge chunks of ice floating on water. Let the ice chunks stand for the earth's plates. Now picture several big logs frozen onto the surface of the ice. They become "part" of the ice. The logs stand for the continents.



When the chunks of ice move, the logs move too. Similarly, when the earth's plates move, the continents move.

In some places, the earth's plates are moving apart (Figure B, top).

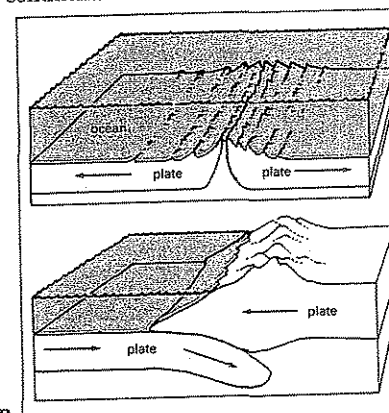


Figure B

Where plates come together, there is great pressure. As the plates continue to "push" against each other, the pressure builds up. Over millions of years, this pressure can cause rocks in the crust to buckle and fold. The upfolds, or anticlines, become folded mountains.

HOW CAN WE SHOW FOLDING?

You can use a stack of colored paper to show how sedimentary rock can be folded. First, arrange the stack in layers of different colored paper (Figure C, top).

Next, slowly but firmly push both ends of the stack of paper toward the center (Figure C, bottom).

1. What do the different colored layers of paper stand for? _____
2. What happens to the layers as the pressure builds up on the ends of the stack? _____

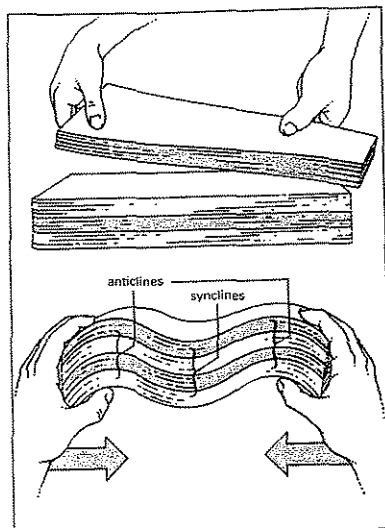
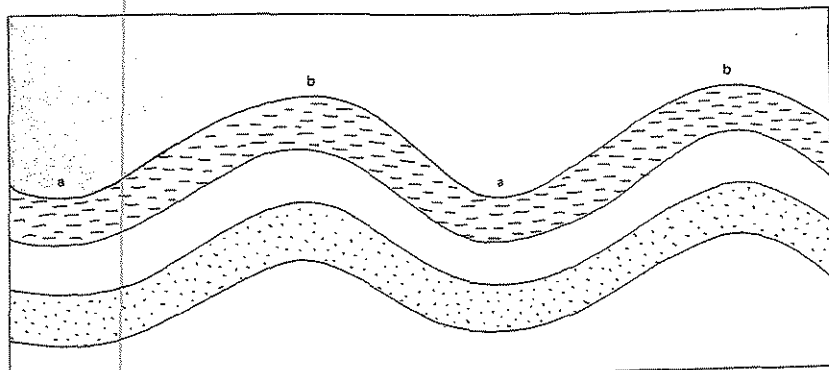


Figure C

WHAT DOES THE DIAGRAM SHOW?

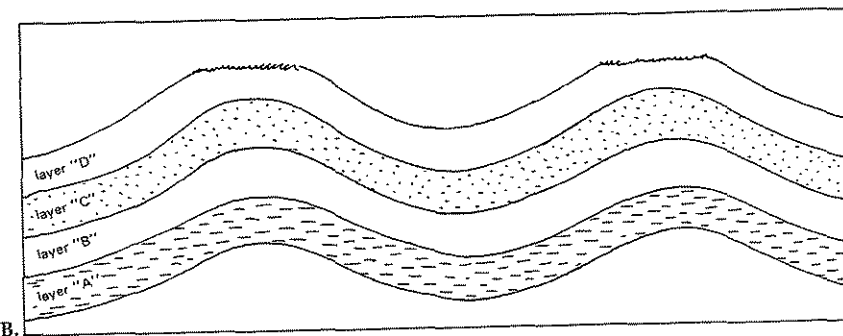
1. The diagram below shows folded rock layers. Study the diagram. Then answer the questions below the diagram.



A.

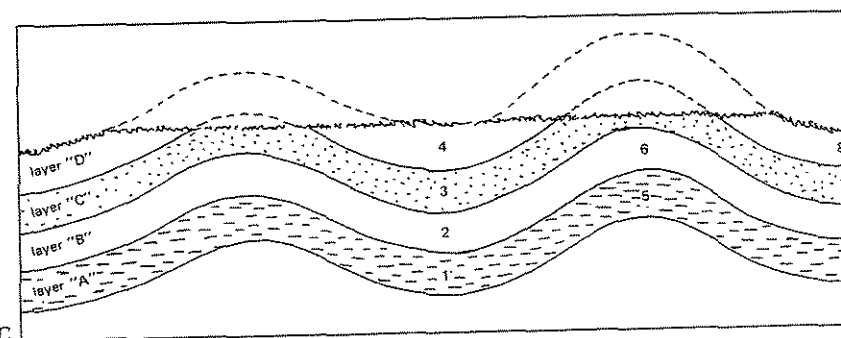
1. The upfolds are lettered _____. 2. The downfolds are lettered _____.

- ii. In time, mountains erode. They become smaller and smaller.



B.

The folded mountain shown above eroded to this flat surface (below).



C.

Answer the following questions. (Circle the correct letter.)

1. Which sedimentary layer was deposited first? A B C D
2. Which sedimentary layer was deposited last? A B C D
3. 1 and 5 are parts of layer A B C D
4. 4 and 8 are parts of layer A B C D
5. 3 and 7 are parts of layer A B C D
6. Which layers have no erosion? A B C D
7. Which layer has been eroded the most? A B C D
8. What has happened to the eroded material? _____

COMPLETING SENTENCES Complete the sentences with the choices below. One of these may be used twice.

builds up	folded mountains	block mountains
streams	synclines	pressures
sedimentary	waves	water
domed mountains	volcanic mountains	anticlines

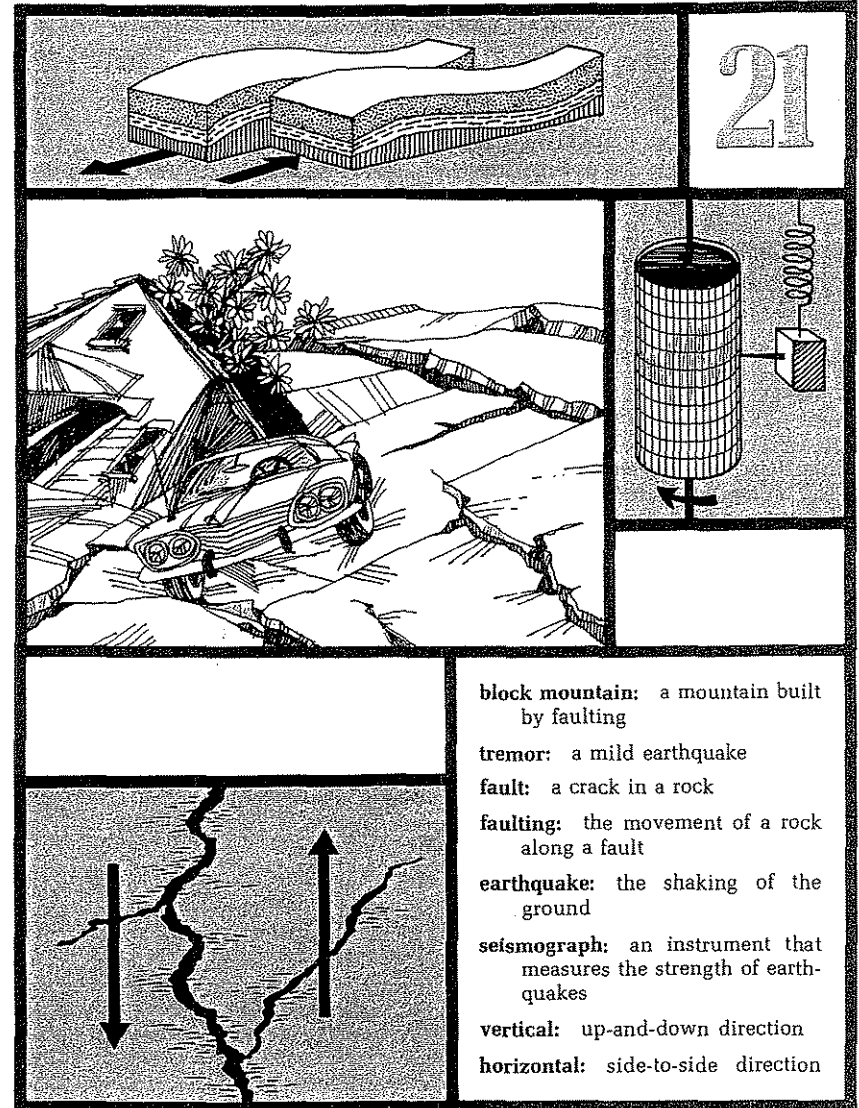
- The main kinds of mountains are _____, _____, _____, and _____.
- The most common mountains are _____.
- Mountain-making _____ the earth's crust.
- Folded mountains are built mostly from _____ rocks.
- _____ inside the earth buckle rocks.
- Folded rock layers look like _____.
- The top parts of folds are called _____.
- The bottom parts of folds are _____.
- Most sediment is carried by _____.
- Most sediment is deposited in _____.

MATCHING Match the two lists. Write the correct letter on the line next to each number.

- | | | |
|----------|--------------------------------|------------------------------|
| 1. _____ | folded, block, domed, volcanic | a) most common mountains |
| 2. _____ | folded mountains | b) downfold |
| 3. _____ | Plate Theory | c) upfold |
| 4. _____ | anticline | d) kinds of mountains |
| 5. _____ | syncline | e) explains folded mountains |

WHAT ARE EARTHQUAKES AND BLOCK MOUNTAINS?

21



It was February 4, 1976, in Guatemala City. The time was 3 A.M. People were asleep. Suddenly the ground began to shake. It shook with great force. Walls tumbled, roofs caved in, whole buildings split in half, hillsides collapsed.

The shaking lasted only 39 seconds. In that short time, 26,000 people died in the city and countryside. Another 60,000 people were injured. Hundreds of thousands more were left without homes.

An earthquake had struck Guatemala. What causes earthquakes?

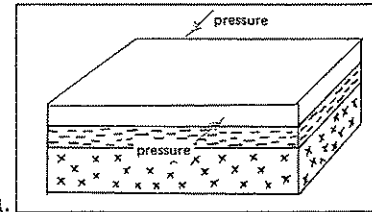
Great pressure inside the earth does not always fold the earth's crust. Sometimes pressure splits rocks. A split in rock is called a *fault*. Faults weaken rocks. Pressure on the rocks builds. Then the pressure eases. When it eases, the blocks of rock move along the fault. The blocks move suddenly—and in opposite directions. The movement shakes the earth. This shaking is called an earthquake.

The movement of rocks along a fault is called *faulting*. There are two kinds of faulting: *side-to-side faulting* and *up-and-down faulting*.

Faulting moves rocks only a short distance. But faulting can happen over and over. Each time the rocks move farther and farther apart.

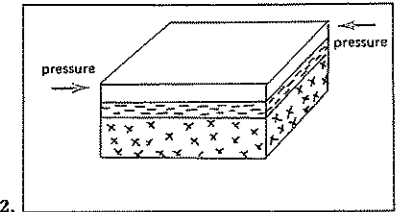
Over millions of years, up-and-down faultings build *block mountains*. The Sierra Nevadas are block mountains. They are still growing.

horizontal faulting
Side-to-side



A-1.

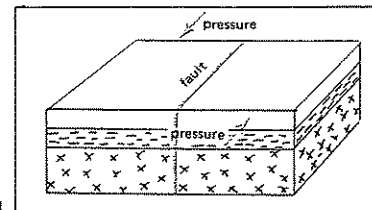
vertical faulting
Up-and-down



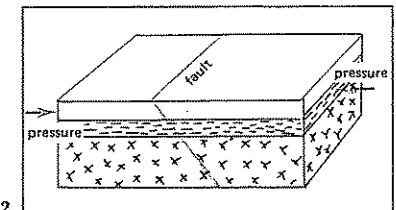
A-2.

Forces inside the earth press against rocks.

The rocks try to stay in one piece.



B-1.

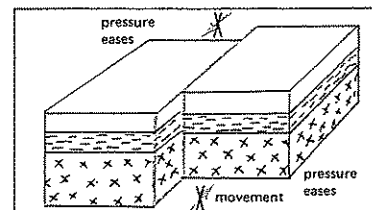


B-2.

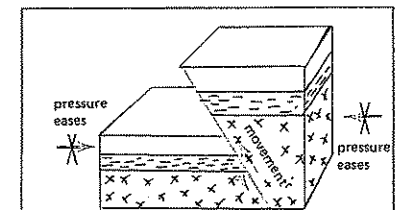
Sometimes the strain is too great.

The rock cracks.

But the split parts do not move yet.



C-1.



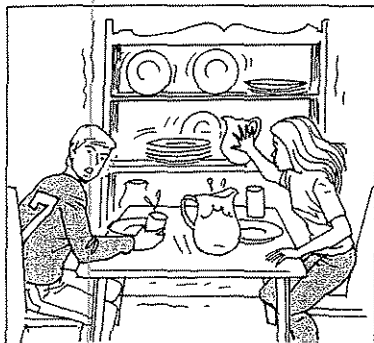
C-2.

More pressure builds.

Then the pressure eases.

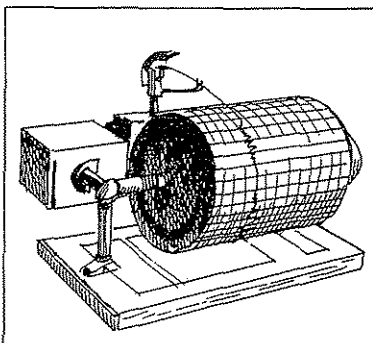
Suddenly, the blocks move in opposite directions.

EARTHQUAKES



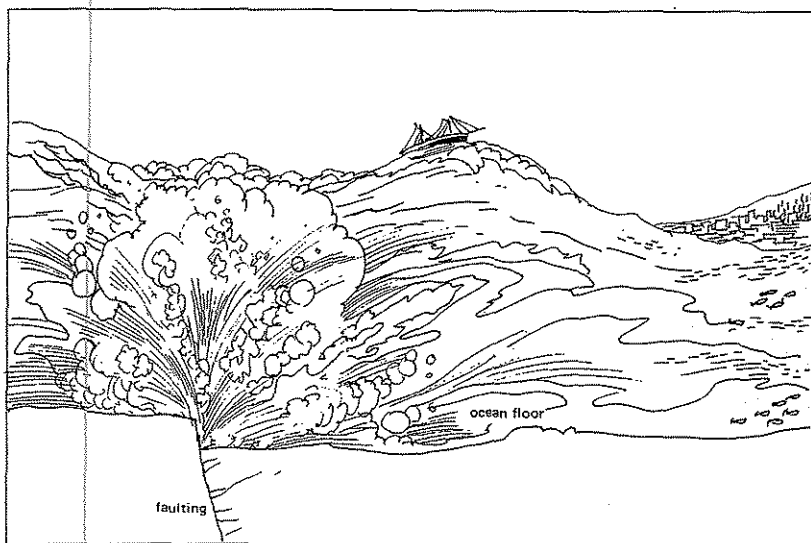
A.

Some earthquakes are very strong. But most earthquakes are mild. A mild earthquake is called a tremor.



B.

A seismograph (SIZE muh graf) measures the strength of earthquakes. There are more than 500 seismograph stations. They are spread over every continent.



C.

Earthquakes can happen in rocks under the ocean. The shaking of the rocks can set off huge tidal waves.

COMPLETING SENTENCES Complete the sentences with the choices below. Two of these may be used twice.

vertical
suddenly
Sierra Nevadas
horizontal

crack
block mountains
faulting

opposite
fault
earthquake

- Pressures in the earth try to _____ rocks.
- A crack in a rock made by pressure is called a _____.
- The movement of rocks along a fault is called _____.
- Faulting rocks move _____ and in _____ directions.
- Two kinds of faultings are _____ faulting and _____ faulting.
- Up-and-down faulting is also called _____ faulting.
- Side-to-side faulting is also called _____ faulting.
- The shaking of the ground from faulting is called an _____.
- Many vertical faultings build _____.
- An example of block mountains are the _____.



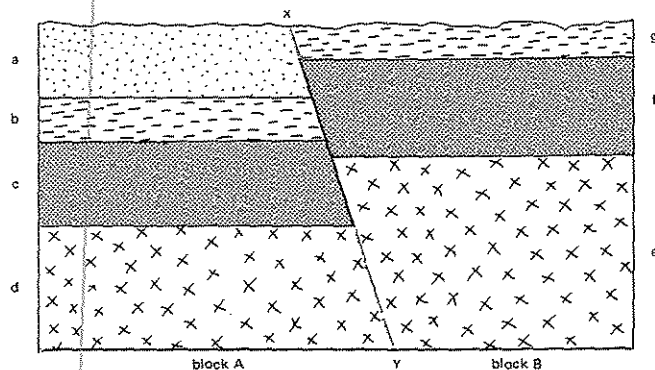
MATCHING Match the two lists. Write the correct letter on the line next to each number.

- | | |
|-------------------------------------|------------------------------|
| 1. _____ fault | a) measures earthquakes |
| 2. _____ seismograph | b) mild shaking of the earth |
| 3. _____ many up-and-down faultings | c) crack in a rock |
| 4. _____ tremor | d) buckled sedimentary rocks |
| 5. _____ folded mountains | e) build block mountains |

WHAT DOES THE PICTURE SHOW?

The rocks in this diagram have faulted. One block has moved up. The other block has moved down.

Study the diagram of the layers carefully. Then answer the questions.



1. Match the layers as they were before faulting. (Answer e, f, or g.)

Part b of block A was once part of _____ of block B.

Part c of block A was once part of _____ of block B.

Part d of block A was once part of _____ of block B.

2. Layer a in block A does not have a match in block B. What happened to it?
(Circle the letter of the right answer.)

- a) It was never there.
- b) It is going to be deposited.
- c) It was worn away.

3. Block A has moved _____
up, down

4. Block B has moved _____
up, down

5. What is line XY called? _____

6. The movement of rocks along a fault is called _____

7. This is an example of _____ faulting.
horizontal, vertical

8. Which is oldest, a, b, c, or d? _____

9. Which is youngest, a, b, c, or d? _____

10. Put on your thinking cap!

- a) This faulting happened _____
a long time ago, a short time ago

- b) How do you know? _____

TRUE OR FALSE Write T on the line next to the number if the sentence is true.
Write F if the sentence is false.

1. _____ Pressure can buckle rocks.
2. _____ Pressure can split rocks.
3. _____ Pressure will always fold rock.
4. _____ Pressure will always split a rock.
5. _____ A fault is a crack.
6. _____ Faulting is a kind of movement.
7. _____ Faulting happens very slowly.
8. _____ A rock can fault only once.
9. _____ Rocks under the ocean can fault.
10. _____ An earthquake lasts a long time.

WORD SCRAMBLE Unscramble each of the following to form a word or term that you have read in this Aim.

1. SERSPRUE _____
2. GALUNFIT _____
3. CKLOB _____
4. METROR _____
5. AQUEERKAHT _____

KEEPING UP WITH SCIENCE

CAN EARTHQUAKES BE CONTROLLED?

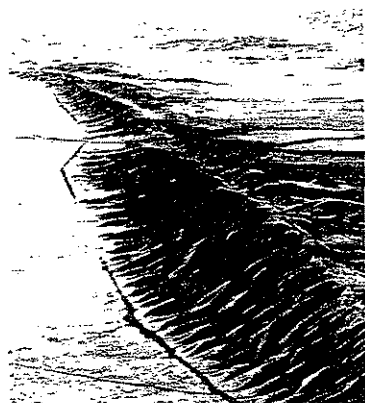
Several years ago, the U.S. Army started pumping liquid chemical wastes into a mile-deep well. The location is near Denver, Colorado.

For many years Denver had experienced frequent and very mild tremors. However, every time the army pumped the liquid waste into the ground, the tremors became stronger. They became mild quakes. It seemed that they were somehow set off by the liquid waste pumped in beneath the surface.

Scientists wanted to find out if this was so. To test the idea, they set up an experiment in an oil field near Rangley, Colorado. This was a perfect site for the experiment. A fault passes through the oil field. Most earthquakes start along faults. Over the years, stress builds up along a fault line. Stress increases. When the stress becomes too great, the rock suddenly snaps apart. The result is a severe earthquake.

At what point is the stress too great? Can underground water play some role in causing rock to snap apart? To investigate this question, the scientists at Rangley did two things:

First, they removed water from a deep well along the fault. This reduced the pressure against the underlying rock. During this period, only one weak tremor was recorded a month.



Then, the scientists added water to the well. This increased the pressure against the underlying rock to 4,000 pounds per square inch. A dramatic change occurred. During this period, a quake was recorded nearly every day. The quakes were mild. They were probably set off by the same rock-splitting that produces major earthquakes. They were the first experimental people-made earthquakes.

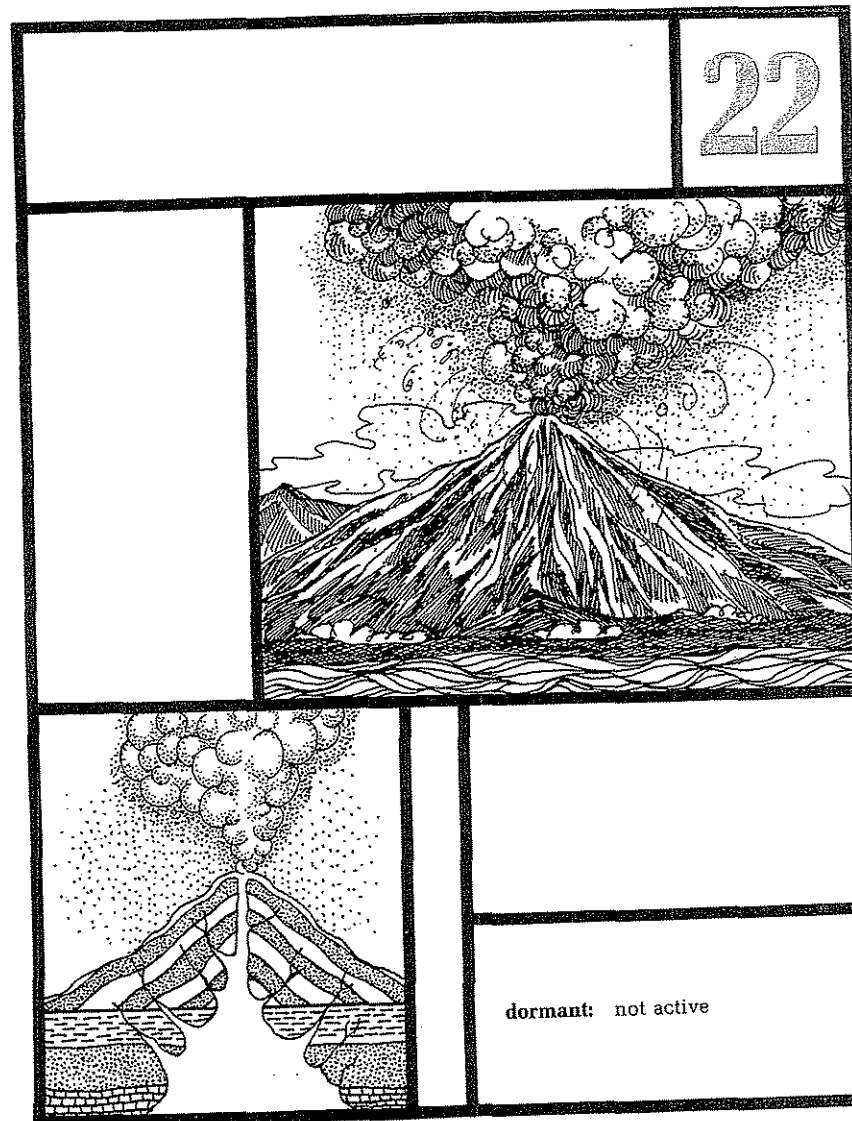
These small artificial quakes would relieve rock stress when it is still weak. The stress is not given a chance to build up thus preventing a major quake.

So it appears that under certain conditions, scientists can set off earthquakes. This raises a most important question: Can this ability be used to control earthquakes? Possibly. Some scientists believe that some major earthquakes can be prevented. How? By producing frequent small quakes.

Experiments are planned to test this theory. Hopefully, the scientists are correct.

WHAT ARE VOLCANIC MOUNTAINS AND DOMED MOUNTAINS?

22



dormant: not active

AIM | What are volcanic mountains 22 and domed mountains?

Did you know that not all crustal rock is solid? Some of the rock is liquid—red-hot melted rock! This liquid rock below the earth's surface is called magma.

Scientists are not exactly sure what causes some crustal rock to melt. But they believe that, once formed, magma collects in "pockets" in the crustal rock.

Magma heats the solid rock around it. Some of that solid rock may melt and become magma. Rock that does not melt will expand. This creates pressure on surrounding rocks. As heat and pressure build up, something has to give. In many cases, a mountain is formed at the earth's surface.

Magma can cause two different kinds of mountains to form—volcanic mountains and domed mountains.

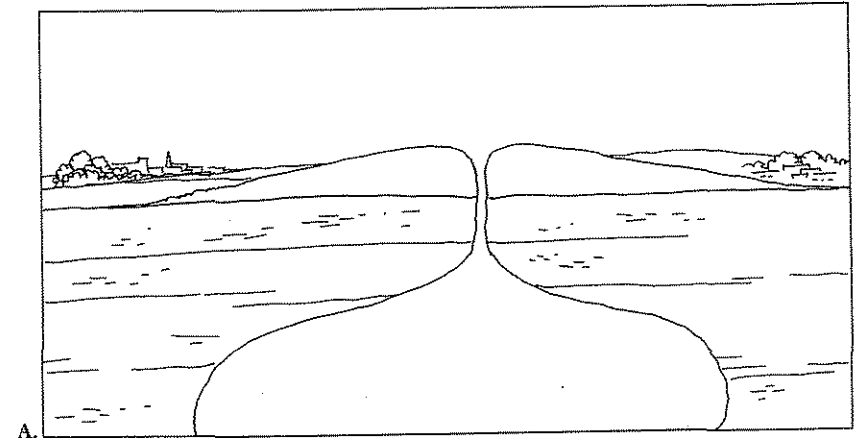
Most people call volcanic mountains volcanoes. Volcanoes form in places where magma forces its way to the earth's surface. Once it reaches the earth's surface, magma is called lava. At the surface, lava cools and hardens, forming igneous rock.

Some volcanoes are quiet. In quiet volcanoes, lava flows gently to the surface. It spreads out and forms a large mountain with gently sloping sides.

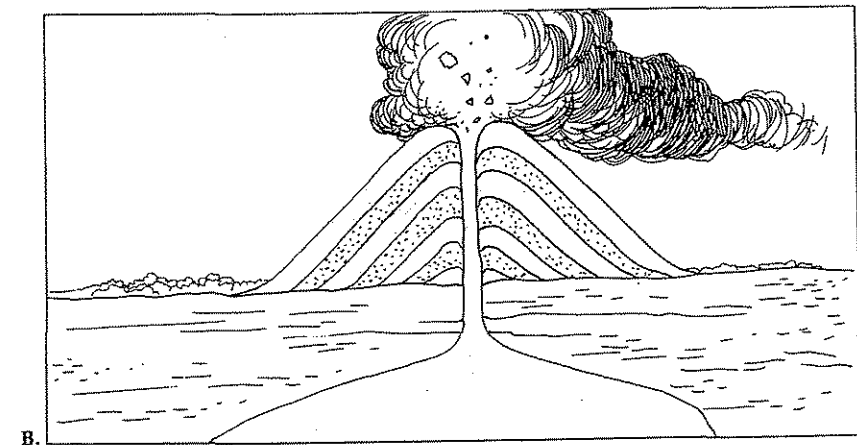
Other volcanoes are explosive. When magma is held underground for a long time, the pressure becomes too great. The magma "explodes" to the surface. These explosions, or eruptions [ee RUP shunz], send lava, boulders, ashes, dust, and gases high into the air. A cone-shaped mountain with steep sides is formed. Between eruptions, a volcano is said to be "sleeping," or dormant.

In some places, rock above a pocket of magma is extra strong. The magma can't force its way to the surface. As pressure builds, the magma bulges. This bulge forces rock above it to rise. At the surface, a domed mountain is formed. Domed mountains are oval or round.

VOLCANOES



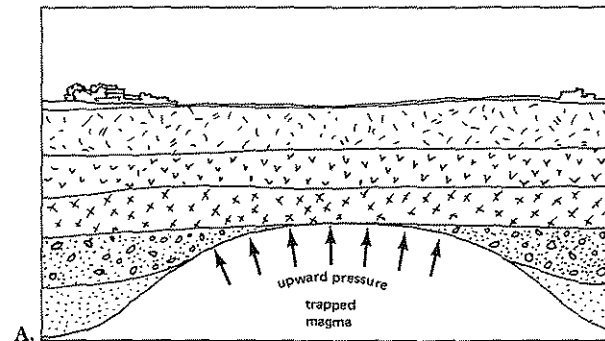
A QUIET VOLCANO



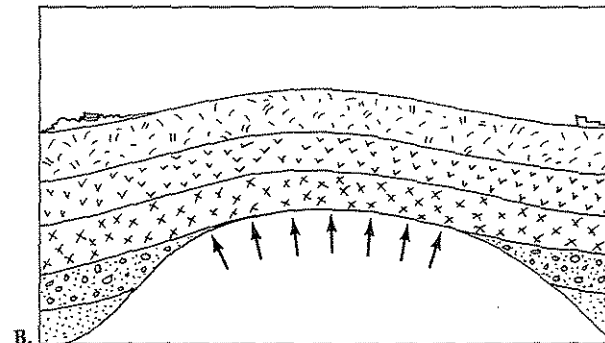
AN EXPLOSIVE VOLCANO

1. The sides of a quiet volcano are _____ steep, gentle _____.
2. The sides of an explosive volcano are _____ steep, gentle _____.
3. Which has a wider base, a quiet volcano or an explosive volcano? _____

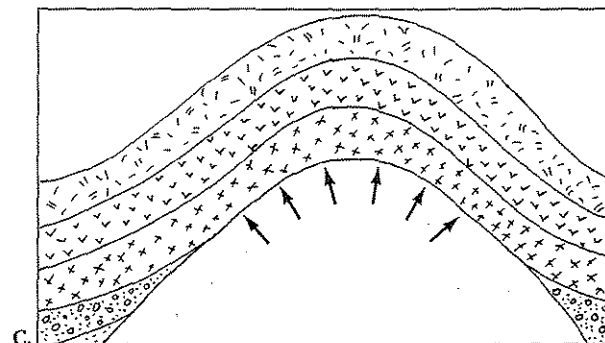
HOW A DOMED MOUNTAIN IS FORMED



Trapped magma builds strong upward pressure.



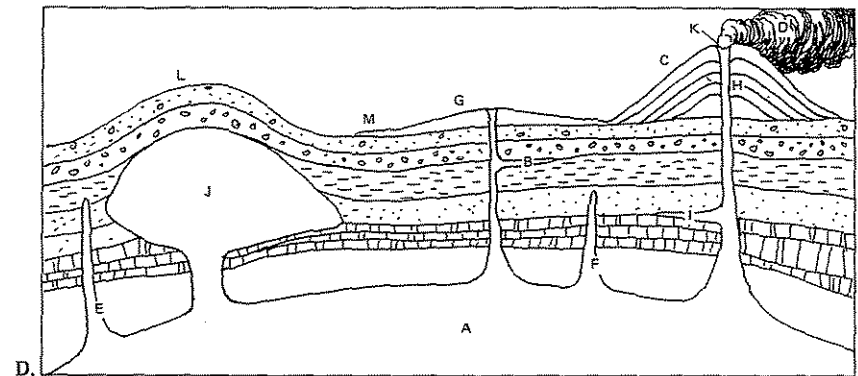
The pressure bulges the land above it.



A great domed mountain is formed.

WHAT DOES THE DIAGRAM SHOW?

The diagram below shows volcanoes, magma, and things that are part of volcanic action. Study the diagram. Then answer the questions below the diagram. Answer by writing in the correct letters.



- I.
 1. explosive volcano _____
 2. quiet volcano _____
 3. lava flow _____
 4. main magma supply _____
 5. domed mountain _____
 6. trapped magma that formed the domed mountain _____
 7. poisonous gases, rocks, cinders, and ashes _____
- II. You have not studied these parts. But see if you can find them from the descriptions.
 8. Sometimes, trapped magma flows between rock layers. This flow is called a sill. The diagram shows two sills. What are their letters? _____
 9. Trapped magma also flows upward between cracks in rocks. This flow is called a dike. Two dikes are labeled. What are their letters? _____
 10. A crater is the cuplike part on top of a volcano. The crater is lettered _____.
 11. A neck is the tube-shaped center of a volcano. The neck is lettered _____.

COMPLETING SENTENCES Complete the sentences with the choices below.

bulge	gets trapped	force its way free
domed mountain	mushroom	

1. Rising magma sometimes _____.
2. Trapped magma tries to _____.
3. The force of trapped magma can make the land _____.
4. Magma that makes land bulge is shaped like a _____.
5. Land pushed up high by trapped magma forms a _____.

TRUE OR FALSE Write T on the line next to the number if the sentence is true.
Write F if the sentence is false.

1. _____ Magma is melted rock.
2. _____ Magma always reaches the earth's surface.
3. _____ Faulting builds domed mountains.
4. _____ Domed mountains are made of layers of lava.
5. _____ Domed mountains are not as high as folded mountains.

COMPLETING SENTENCES Complete the sentences with the choices below. Two of these words may be used twice.

poisonous gases	lava	oozes
magma	gentle	solid materials
steep	quiet	below the earth's surface
explosive	steam	explode

1. The materials that build volcanoes come from _____.
2. Melted rock inside the earth is called _____.
3. Melted rock that has come to the surface is called _____.
4. The two types of volcanoes are _____ volcanoes and _____ volcanoes.
5. Quiet volcanoes do not _____.
6. The slopes of quiet volcanoes are _____.
7. The slopes of explosive volcanoes are _____.
8. Magma _____ out from quiet volcanoes.
9. Magma comes out of explosive volcanoes. A great deal of _____, _____, and _____ also shoots out.
10. Most volcanoes are both _____ and _____.

MATCHING Match the two lists. Write the correct letter on the line next to each number.

- | | |
|----------------------------|---------------------------------------|
| 1. _____ quiet volcano | a) steep slopes |
| 2. _____ explosive volcano | b) melted rock inside the earth |
| 3. _____ lava | c) can awaken any time |
| 4. _____ magma | d) gentle slopes |
| 5. _____ dormant volcano | e) melted rock on the earth's surface |

WORD SEARCH

The words in this list are hidden within the groups of letters. Try to find each word. When you find it, draw a line around the word. The spelling may go backwards or forwards in any direction: up-and-down, across, or diagonally.

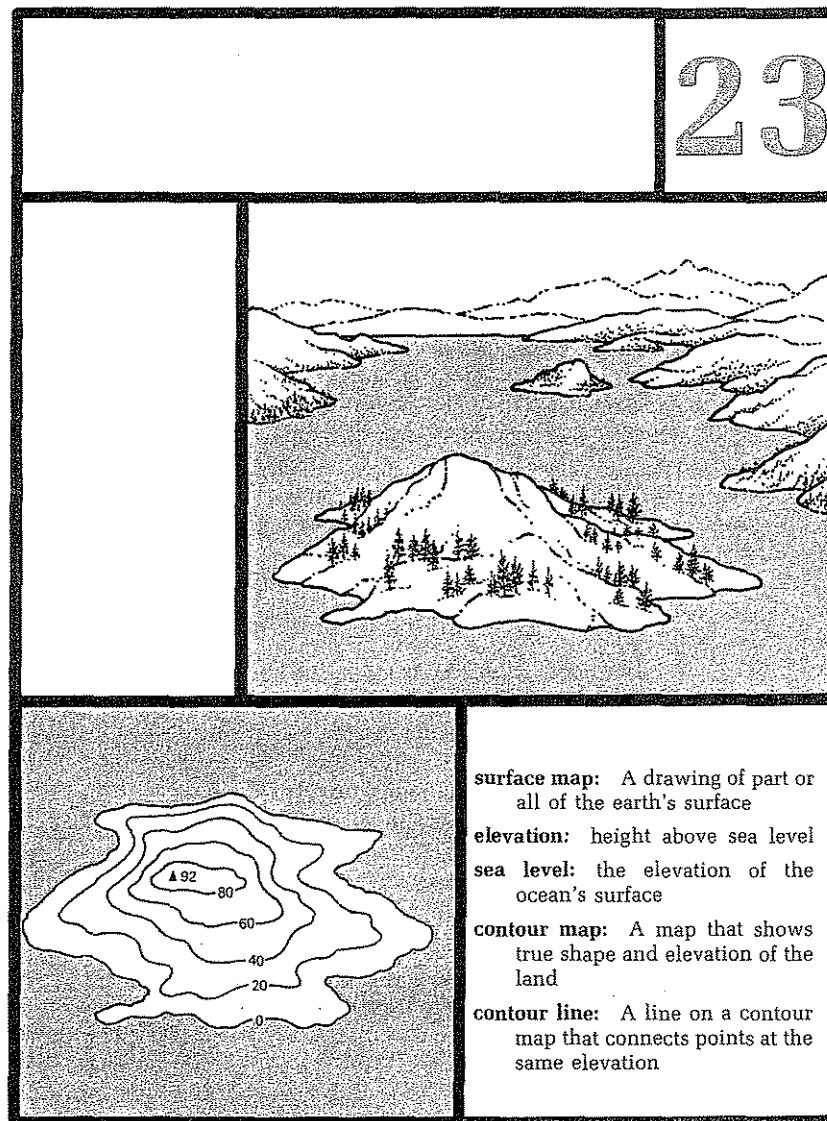
WAVES
BAR
LAGOON
ANTICLINE
SYNCLINE
FOLDED
FAULT
VOLCANO
DOMED
MAGMA
QUIET

A	Q	T	P	T	E	Q	V	O	G
M	A	G	M	A	F	B	O	R	A
C	A	N	E	O	V	G	L	T	S
Q	U	I	T	D	N	O	C	L	Y
M	A	Q	U	I	E	T	A	U	N
D	I	K	W	S	C	M	N	A	C
E	L	N	D	E	D	L	O	F	L
T	Y	E	R	V	O	V	I	D	I
S	F	N	L	A	G	O	O	N	N
P	V	O	T	W	B	A	Q	U	E

REACHING OUT Which will erode faster, a quiet volcano or an explosive volcano? Why?

WHAT IS A CONTOUR MAP?

23



8. Compare the drawing of the island with the contour map.
- Which one gives more information? _____
 - Which one is more accurate? _____
 - Which one is more useful? _____

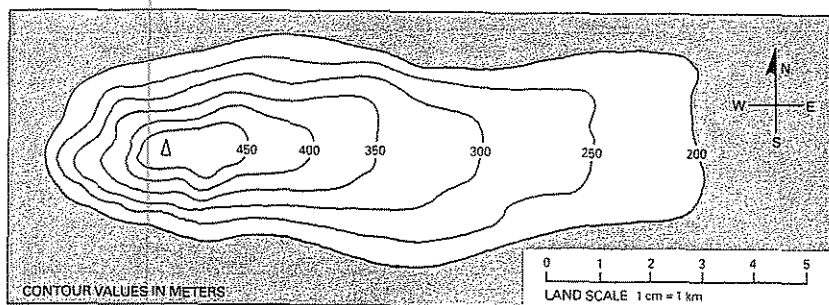


Figure C

Let's try another.

- By compass direction . . .
 - the _____ side of this landform has the steepest slope.
 - the _____ side of this landform has the gentlest slope.
- The contour interval of this map is _____ meters.
- The lowest elevation shown is _____ meters.
- Which of these heights could be the exact elevation of the peak? a) 520 meters b) 420 meters c) 475 meters

SOMETHING EXTRA

You can learn more from a contour map than just the shape and slope of the land. Contour maps also tell you something about streams. And about "dips," or depressions, in the land.

STREAMS

The head of a stream is the place where it starts. The place where it ends, in a lake or ocean, is called the mouth. Look at figure D. Can you find a stream?

- What letter is at
 - the head of the stream? _____
 - the mouth of the stream? _____

- Where contour lines "cross" a stream, they _____.
- Everyone knows that water flows _____ uphill, downhill.
 - In other words, water flow from a _____ elevation to a _____ elevation.
higher, lower
- At a stream, contour lines seem to form "arrows." Each "arrow" points . . .
 - toward the _____ of the stream.
head, mouth
 - _____ upstream, downstream
 - _____ the direction of flow.
toward, away from

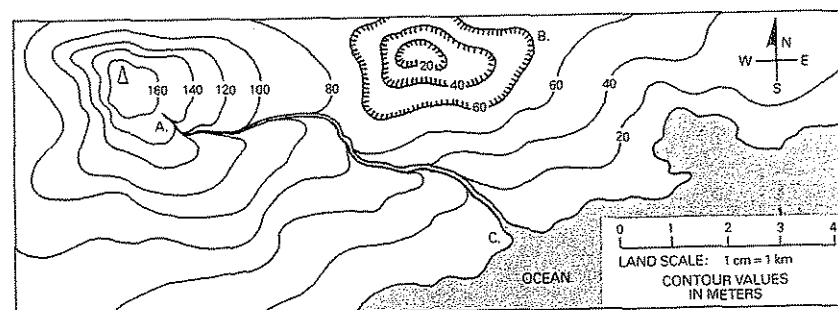
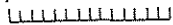


Figure D

DEPRESSIONS

Sometimes a bowl-like dip, or depression, occurs on a fairly flat surface. These are shown by special contour lines called depression contours. A depression contour is shaded, or hachured, on one side, like this . The hachures point down into the depression.

Depression contours are just like regular contour lines. They show the shape of the depression. They also show the slope of the sides of the depression.

Look at the depression beside letter B on the map above.

- The elevation at the top of the depression is _____ meters.
- The _____ side of the depression has the steepest slope.
north, south, east, west
- Which of these could be the exact elevation at the bottom of the depression? a) 40 meters b) 20 meters c) 10 meters

COMPLETING SENTENCES Complete the sentences with the words below.

steep
contour lines
zero (0)

contour map
gentle
contour interval

depression contours
elevation
hachures
sea level

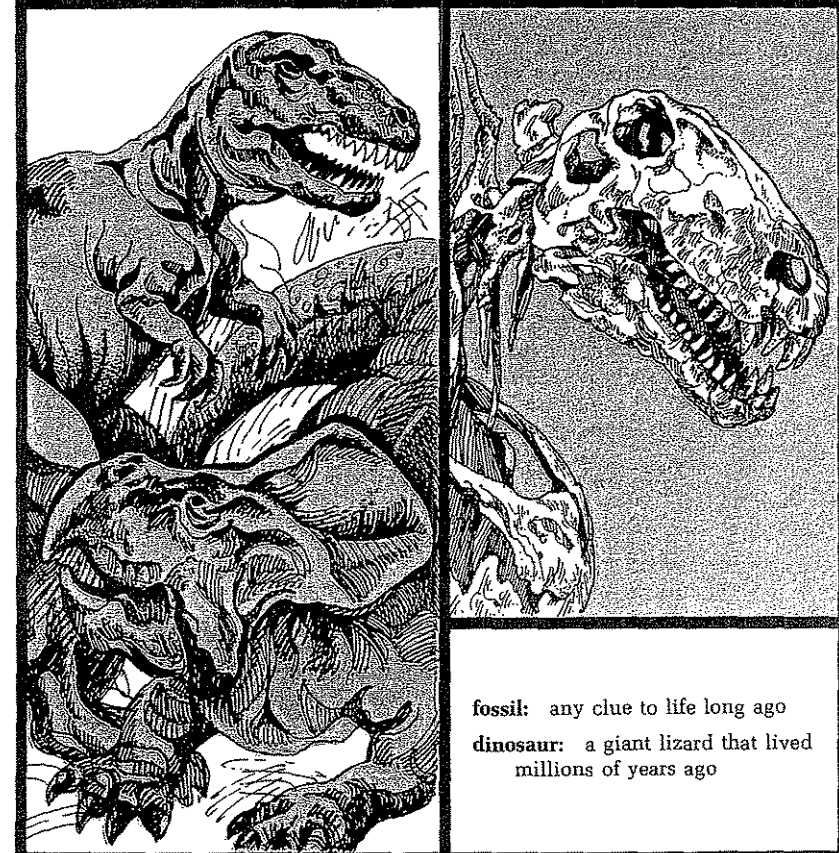
1. A map that accurately shows the shape and changing elevations of the land is called a _____.
2. The height of a location is called its _____.
3. Contour maps use _____ to show shape and elevation.
4. All elevations are measured from _____.
5. The difference in elevation between two neighboring contour lines is called the _____.
6. The number value of sea level is _____.
7. Dips in a fairly flat surface are shown by _____.
8. Contour lines that are close together indicate a _____ slope.
9. The shading marks on a depression contour are called _____.
10. Contour lines that are far apart indicate a _____ slope.

MATCHING Match the two lists. Write the correct letter on the line next to each number.

- | | |
|------------------------------|---|
| 1. _____ head | a. height above sea level |
| 2. _____ depression contours | b. show dips in a flat surface |
| 3. _____ elevation | c. where a stream starts |
| 4. _____ contour interval | d. has zero elevation |
| 5. _____ mouth | e. difference between two neighboring contour lines |
| 6. _____ sea level | f. where a stream ends |

HOW DO WE KNOW THAT THERE WAS LIFE MILLIONS OF YEARS AGO?

24



fossil: any clue to life long ago
dinosaur: a giant lizard that lived millions of years ago

AIM | How do we know that there 24 | was life millions of years ago?

Have you ever visited a zoo? Did you see any living dinosaurs? Why not?

The answer is simple. There are no living dinosaurs. No person has ever seen a living dinosaur. Dinosaurs are extinct. That means that all dinosaurs are dead.

How do we know that dinosaurs ever lived?

Dinosaurs and other extinct animals and plants left traces—or clues—behind. These clues tell us that they once lived. The traces of past life are called fossils.

Billions and billions of plants and animals have lived and died. But very few have become fossils. Conditions had to be right for fossils to form. Usually conditions were not right for fossils.

What are good conditions for fossils to form?

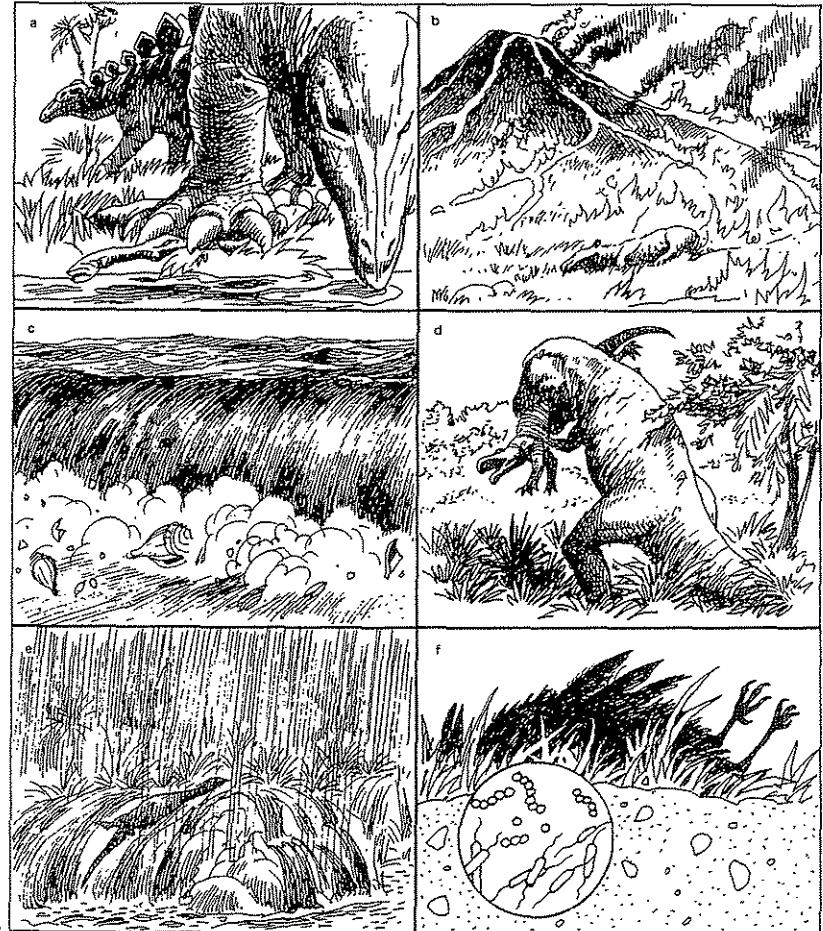
1. Hard parts, like bone, teeth, shell, and wood are most likely to form fossils. Softer parts, like flesh, fur, and petals do not leave many fossils.

2. The remains must be around long enough to form a fossil. What is left when a plant or animal dies is known as "the remains." Usually weather, living animals, and other things destroy the remains quickly. There is no time for a fossil to form.

3. Quick burial keeps away air and other things that can rot dead plants and animals. Quick burial also prevents other animals from eating or crushing the remains.

WHY DO FEW REMAINS LAST?

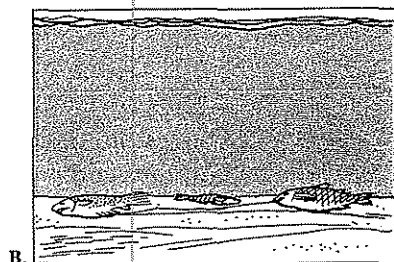
Not all organisms become fossils. Remains of plants and animals are destroyed in many ways. The diagram below shows some of the ways remains are destroyed. Study the diagram. Then fill in the blanks below by writing in the letter that fits the description.



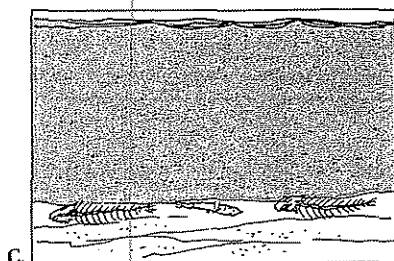
A.

1. weathering _____
2. remains eaten by other animals _____
3. volcano activity _____
4. bacteria (rotting) _____
5. wave action _____
6. crushing _____

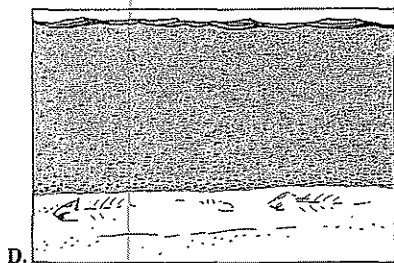
Most fossils are found in sedimentary rocks. They are fossils mainly of marine animals. Marine animals are animals that live in water. This is how marine fossils are formed.



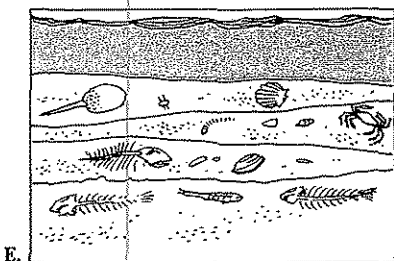
Marine animals die and settle to the bottom.



Sediment starts to cover the remains. Usually, the soft parts decay before the covering is finished.



The sediment now completely covers the remains. This helps keep the hard parts from decaying.



Steps B, C, and D happen over and over again. More sediment builds more layers. Each layer has fossils.

COMPLETING SENTENCES Complete the sentences with the choices below. One of these may be used twice.

crush
wood
rot
do not
teeth

muscles
shell
fossils
bone
hard parts

skin
old
remains must not be destroyed
remains
rapid burial

- Traces or clues of past life are called _____.
- Most plants and animals _____ become fossils.
- Three good conditions for forming fossils are _____, _____, and _____.
- Examples of hard parts are _____, _____, and _____.
- Examples of soft parts are _____ and _____.
- A dead organism is called the _____ of that organism.
- Air and bacteria help _____ remains.
- Walking animals can _____ remains.
- _____ keeps air and bacteria away from dead organisms.
- A fossil is always _____.

MATCHING Match the two lists. Write the correct letter on the line next to each number.

- | | |
|---------------------------|-----------------------------------|
| 1. _____ fossil | a) only fossils are left |
| 2. _____ quick burial | b) examples of soft parts |
| 3. _____ dinosaurs | c) examples of hard parts |
| 4. _____ bone and teeth | d) any clue of past life |
| 5. _____ muscles and skin | e) keeps oxygen and bacteria away |

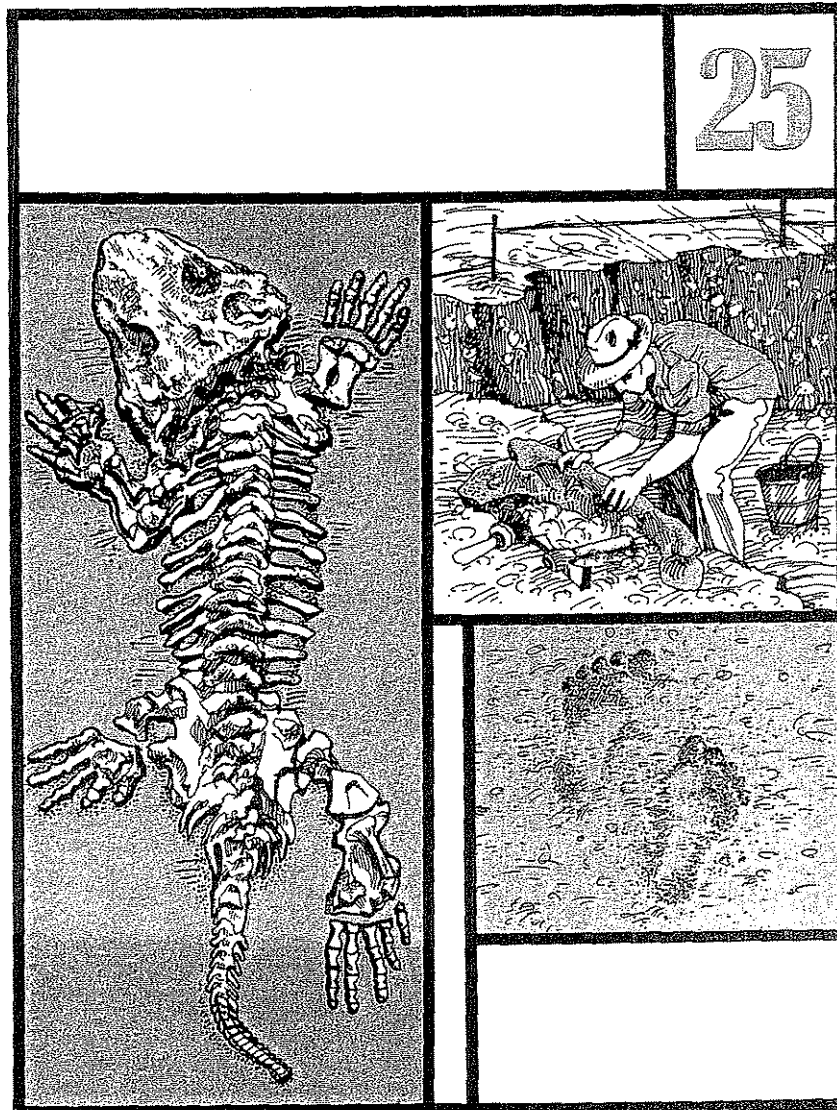
TRUE OR FALSE Write T on the line next to the number if the sentence is true.
Write F if the sentence is false.

1. _____ All animals become fossils.
2. _____ Most animal and plant remains are destroyed.
3. _____ Fossils are remains of recent life.
4. _____ Bone is harder than skin.
5. _____ There are more bone fossils than skin fossils.
6. _____ Remains left on the ground decay easily.
7. _____ Most fossils were formed on land.
8. _____ Rapid burial speeds decay.
9. _____ Most fossils are found on top of rocks.
10. _____ Limestone usually contains fossils.

REACHING OUT Most fossils are deposited in water. How do scientists find them?

WHAT ARE THE DIFFERENT KINDS OF FOSSILS?

25



AIM | What are the different kinds 25 of fossils?

People who study fossils are detectives of a kind. They "read" the clues they find in fossils. Then they try to tell us what happened in the past.

There is more than one kind of fossil. Each kind gives special clues to the past. By "reading" the history of fossils, we have some idea of what life was like millions—even billions—of years ago.

The most common kinds of fossils are molds, casts, prints, changed hard parts, and actual remains.

MOLDS Many plants and animals were buried in fine sediment. In time, the sediment hardened around them. After a while, the plant or animal rotted. But a space was left in the hardened sediment. The space is the same size and shape as the plant or animal. This space is called a *mold*.

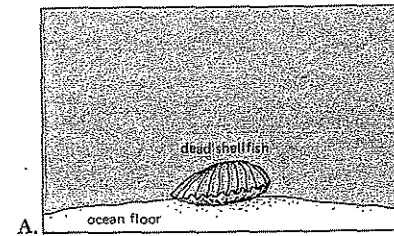
CASTS Sometimes material fills a mold and then hardens. The hardened material is the same size and shape as the plant or animal that left the mold. The hardened material formed by the mold is a *cast*.

PRINTS Animals have walked over soft mud and left footprints. Some animals have lain down in mud and left body prints. Prints are outlines that were made on soft mud that later hardened.

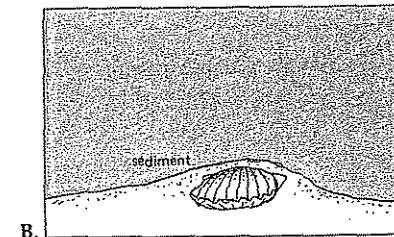
Footprints can tell us how an animal walked and how big it was. Body prints tell us the shape of the body and, sometimes, how skin looked.

You will read about the other fossils in Aim 26.

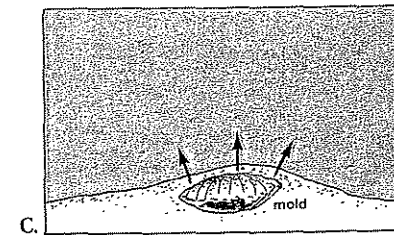
HOW NATURE MAKES MOLDS AND CASTS



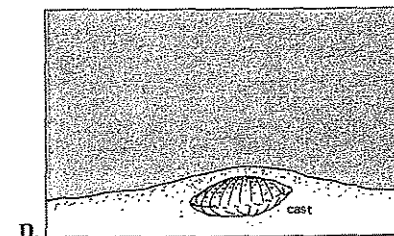
The plant or animal dies and settles.



Sediment covers the remains. The sediment then hardens.



The plant or animal rots. This leaves an empty space called a mold.



Nature slowly fills the mold with other materials. The filled-in material is the cast.

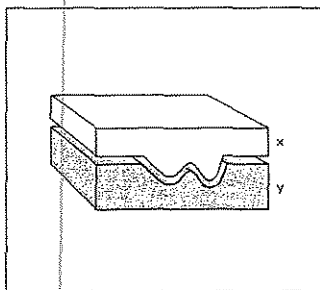
WHAT DO THE PICTURES SHOW?

Look at the questions and the pictures. Then answer the questions.

1. The remains or traces of animals or plants that lived long ago are called _____.

2. Name three forms of fossils. _____, _____, _____.

3.



Look at Figure A. It has two parts (x and y). One of these is a mold; the other is a cast.

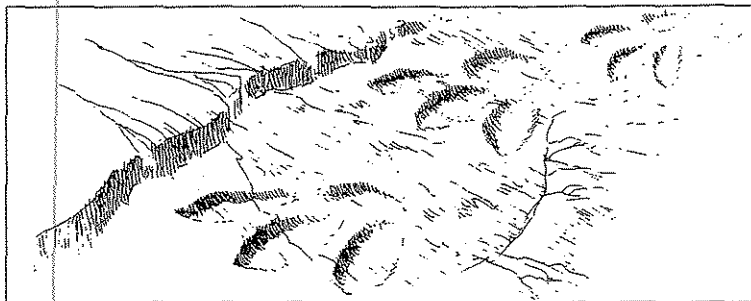
A.

- a) The mold is _____.

- b) The cast is _____.

4. Which was made first, the mold or the cast? _____

5.



B.

- a) What do we call this kind of fossil? _____

- b) On what kind of material was it made? _____

TRUE OR FALSE

Write T on the line next to the number if the sentence is true. Write F if the sentence is false.

1. _____ Every organism becomes a fossil.
2. _____ There are more teeth fossils than skin fossils.
3. _____ Most fossils are found in igneous rocks.
4. _____ All fossils were laid down in water.
5. _____ Most fossils were laid down in water.
6. _____ Dinosaurs left footprints wherever they walked.
7. _____ Molds and casts are actual remains.
8. _____ Molds were made before casts.
9. _____ Molds and casts show the actual size of organisms.
10. _____ There are some fossils of every organism that ever lived.

MATCHING

Match the two lists. Write the correct letter on the line next to each number.

- | | |
|---------------------------------------|-----------------------------------|
| 1. _____ fossil | a) always laid down on land |
| 2. _____ fossil prints | b) least likely to become fossils |
| 3. _____ fossil molds | c) most likely to become fossils |
| 4. _____ organisms with no hard parts | d) any clue to past life |
| 5. _____ organisms with hard parts | e) most are formed in water |

WORD SCRAMBLE Unscramble each of the following to form a word or term that you have read in this Aim.

1. SLOSFI _____
2. LOMD _____
3. TACS _____
4. TRIPN _____
5. TEDMINSE _____

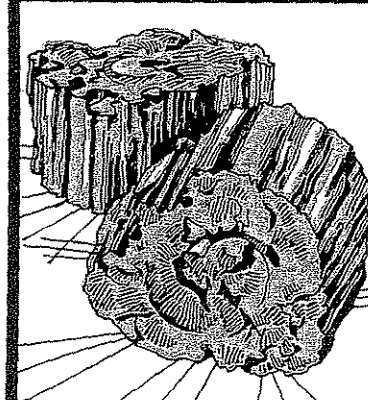
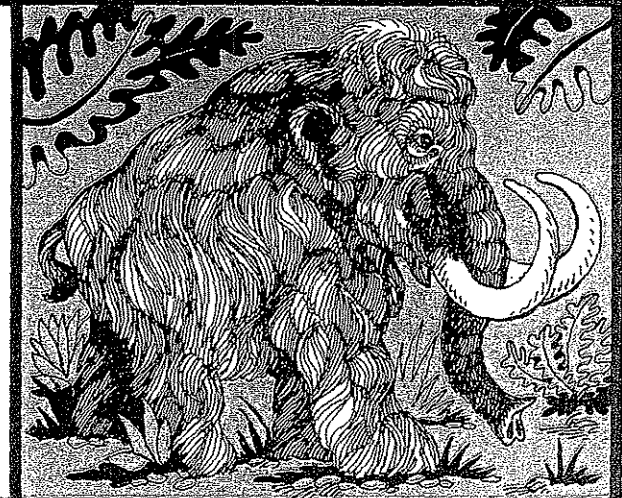
REACHING OUT Two different sets of fossil footprints are found on one rock. One of the imprints is deeper than the other.

Does this definitely mean that a heavier animal made the deeper print? _____

Give a reason for your answer. _____

WHAT ARE CHANGED AND UNCHANGED REMAINS?

26



preserve: to protect, keep from spoiling
amber: a hardened tree sap
natural mummy: a fossil formed by drying

AIM | What are changed and 26 | unchanged remains?

Molds, casts, and prints are not really the remains of animals and plants. There are fossils that are the real, preserved remains of animals or plants. These fossils are changed hard parts and actual remains.

CHANGED HARD PARTS Over a long period of time, tough minerals may fill in tiny spaces in dead plants and animals. The filling in makes the remains much harder than they once were.

Petrified wood is an example of this kind of fossil. Petrified wood is wood that has changed to real stone.

ACTUAL REMAINS Once in a while, an actual whole animal, or parts of an animal or plant are preserved. Special conditions preserve actual parts. For example:

- Extreme cold keeps remains from rotting. About fifty woolly mammoths have been found preserved in ice in the frozen north. These huge animals lived more than 25,000 years ago.
- Extreme dryness also prevents rotting. Fossils formed by drying are called natural mummies.
- Amber is hardened tree sap. Many insects have been preserved in amber. Some lived more than 40 million years ago.
- Tar trapped and preserved many animals. A famous "tar pit" is in La Brea, California. More than 300 different kinds of plant and animal fossils have been found there.

SOME REAL FOSSILS



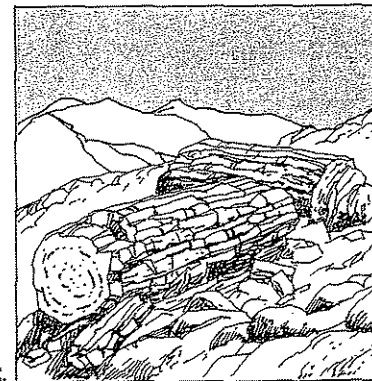
The first frozen woolly mammoth was found in 1799.

Most mammoth fossils were well preserved. In some, even undigested food in the stomach was still fresh.



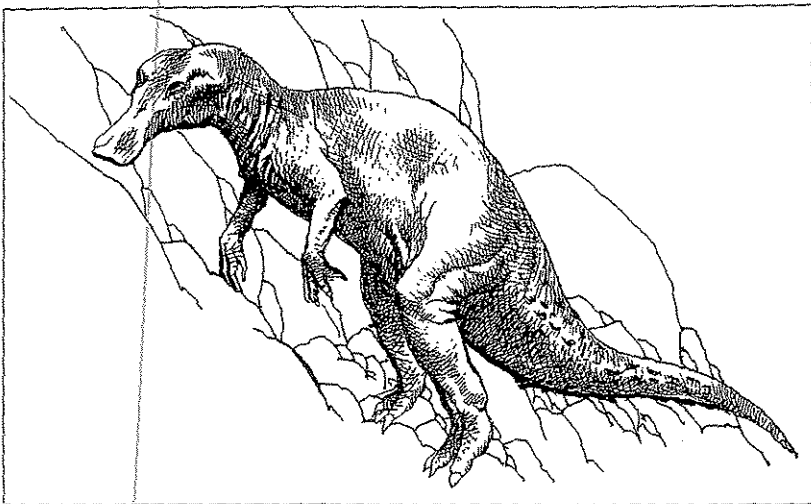
Early Russian explorers ate the meat from some of these animals.

What would you say if you were served a steak that was 25,000 years old?



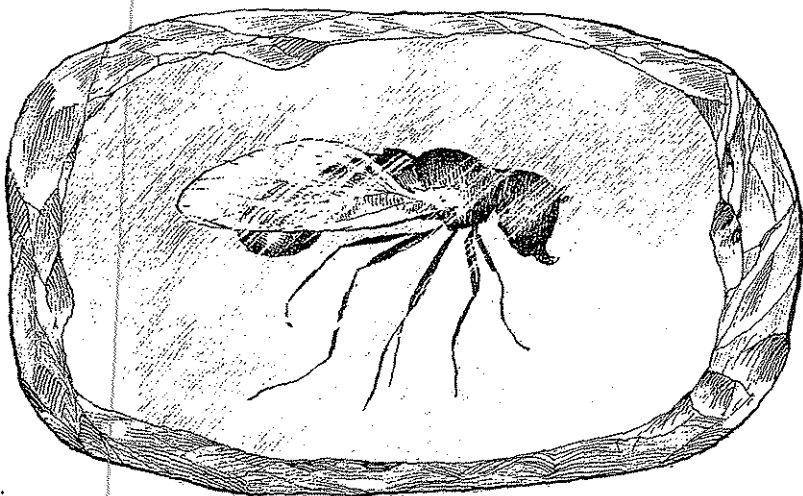
About 150 million years ago, this petrified log was a tree. After it fell, it may have been covered with swamp or river sediments. Or it may have been covered with volcanic ash like that from the Mount Saint Helens explosion of 1980 in the State of Washington.

This log was covered with sediment tens or even hundreds of meters thick. After millions of years, the sediment was eroded away by running water and wind. The mineralized log was uncovered.



D.

A "natural mummy" of a duck-billed dinosaur was discovered. It lived about 100 million years ago.



E.

This insect was trapped in amber about 180 million years ago.

COMPLETING SENTENCES

Complete the sentences with the choices below.

amber
hard
tar
stone

extreme cold
rotting
petrified wood

tough minerals
natural mummies
actual remains

1. An example of a fossil with changed hard parts is _____.
2. In petrified wood, _____ filled tiny holes in the wood.
3. Petrified wood is very _____.
4. Petrified wood has turned to real _____.
5. Under special conditions, _____ become fossils.
6. In the Far North, _____ has preserved woolly mammoths.
7. Dried fossils are called _____.
8. Fossil insects have been found in hardened sap called _____.
9. At La Brea, California, whole remains have been preserved in _____.
10. Extreme cold, extreme dryness, amber, and tar preserve fossils because they prevent _____.

MATCHING

Match the two lists. Write the correct letter on the line next to each number.

- | | |
|--------------------------|--------------------------|
| 1. _____ woolly mammoths | a) preserved in amber |
| 2. _____ insects | b) makes natural mummies |
| 3. _____ extreme dryness | c) wood turned to stone |
| 4. _____ La Brea | d) preserved by cold |
| 5. _____ petrified wood | e) tar pits |

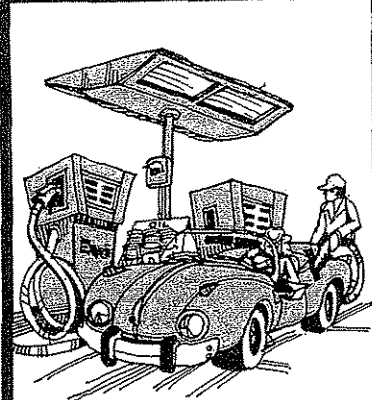
TRUE OR FALSE Write T on the line next to the number if the sentence is true.
Write F if the sentence is false.

1. _____ All fossils are actual remains.
2. _____ Most fossils are actual remains.
3. _____ Only a few fossils are actual remains.
4. _____ A cast is an actual remain.
5. _____ Petrified wood is wood that has changed to rock.
6. _____ Amber and tar preserve remains because they keep away oxygen.
7. _____ Cold makes things rot quickly.
8. _____ Many remains are preserved in jungles.
9. _____ Most fossils were formed on land.
10. _____ Most fossils are found in sedimentary rocks.

REACHING OUT How does very low temperature prevent rotting?

WHAT ARE FOSSIL FUELS?

27

fuel: something that can be burned for energy

bog: wet spongy ground with dead plants

Coal, oil, and natural gas are sometimes called *fossil fuels*. What is a fossil fuel?

A fuel is something we burn for energy. Not all fuels are fossil fuels. Fossil fuels are fuels that come from living things of the past.

About 325 million years ago, there were great swamps. The land was warm. Thick forests grew. As the plants aged and died, they fell into the swamps. Other forests grew. They too grew old and fell. Still other forests grew and fell. This happened over and over.

The fallen plants decayed. They formed a thick, muddy bog. Then the sea covered the bog with heavy sediment. The pressure of the sediment slowly changed the decayed wood. The wood turned black and became very hard. The wood was no longer wood. It had become coal.

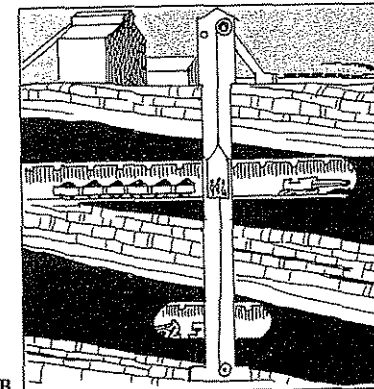
It took nature millions of years to make coal. Coal is an important fossil fuel.

Oil and natural gas are also fossil fuels. Scientists believe that they were formed from simple water plants and animals.

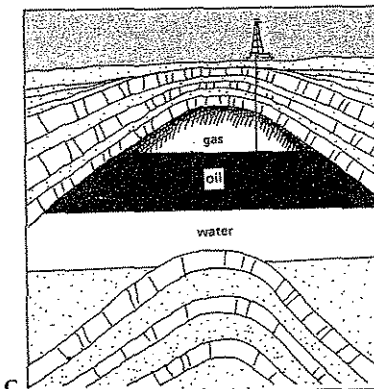
FOSSIL FUELS



A.



B.



C.

Thick forests of 325 million years ago became the coal that we use today.

What kind of energy makes forests grow? _____

Coal is found in layers.

Where did the sediment come from that covered each layer of coal? _____

Scientists believe that 6 to 24 meters (20 to 80 feet) of plant material is needed to form a layer of coal just one-third of a meter (one foot) thick.

Oil is found mostly in anticlines.

Usually where there is oil, there is also natural gas.

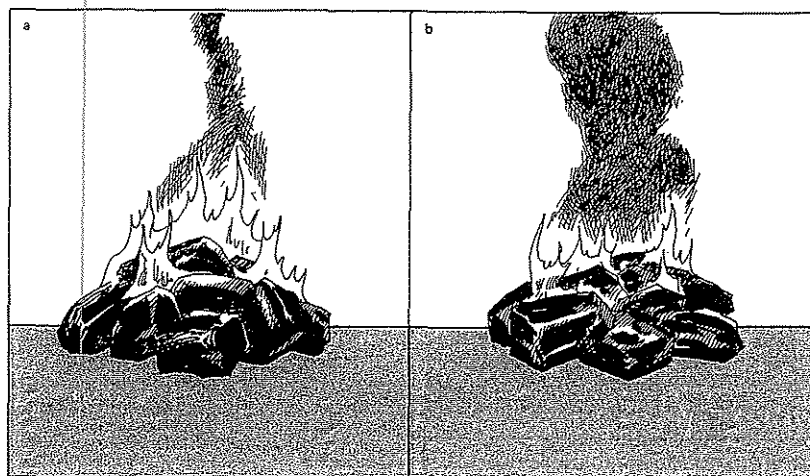
COAL

There are four main kinds of coal. The most common are *bituminous* (bih TOO mu nus) and *anthracite* (ANTH ruh site).

- Bituminous coal is called "soft" coal.
- Anthracite coal is called "hard" coal.
- Bituminous coal is not really soft. It just is not as hard as anthracite coal.
- Anthracite coal gives more heat and burns with less smoke than bituminous coal.

The diagrams below show coal burning. One is bituminous. The other is anthracite.

Study the diagrams. Then answer the questions below.



D.

1. Which fuel is anthracite coal? _____
2. Which fuel is bituminous coal? _____
3. Which one gives more pollution? _____
4. Which one gives less pollution? _____
5. Does any coal give no pollution? _____

MULTIPLE CHOICE

In the space on the right, write the letter that completes each sentence best.

1. We get energy by burning _____
 a) swamps.
 b) fuel.
 c) sediment.
 d) electricity.
2. The energy in fuel came from _____
 a) gas.
 b) electricity.
 c) the sun.
 d) coal.
3. Coal comes from _____
 a) fuel.
 b) sediment.
 c) molds.
 d) plants.
4. About 325 million years ago, much of the earth was _____
 a) cold and damp.
 b) warm and dry.
 c) warm and moist.
 d) cold and dry.
5. About 325 million years ago, there were many _____
 a) scientists.
 b) thick forests.
 c) coal shovels.
 d) gas stations.
6. When sediment was covering a bog, the bog was _____
 a) cold and dry.
 b) under water.
 c) on a mountain.
 d) on ground level.
7. Coal is a fossil fuel because _____
 a) it was formed a long time ago.
 b) it is found in layers.
 c) it comes from prehistoric plants and gives energy.
 d) it started as a bog.
8. Which of these is not a fossil fuel? _____
 a) coal
 b) oil
 c) uranium
 d) natural gas

MATCHING Match the two lists. Write the correct letter on the line next to each number.

- | | |
|-----------------------------|---------------------------|
| 1. _____ bituminous | a) coal, oil, natural gas |
| 2. _____ anthracite | b) start of coal |
| 3. _____ fossil fuels | c) soft coal |
| 4. _____ bog | d) where coal is found |
| 5. _____ sedimentary layers | e) hard coal |

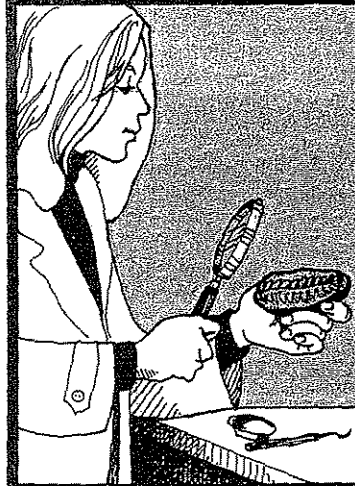
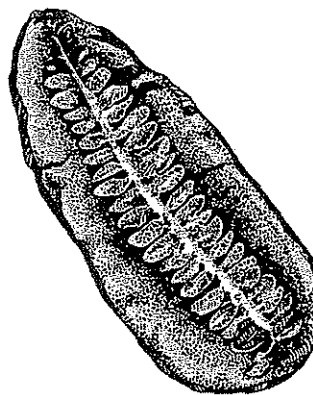
TRUE OR FALSE Write T on the line next to the number if the sentence is true. Write F if the sentence is false.

1. _____ All fuels burn.
2. _____ Wood is a fuel.
3. _____ Wood is a fossil fuel.
4. _____ Coal is a fossil fuel.
5. _____ Coal is the only fossil fuel.
6. _____ All fuels give the same amount of energy.
7. _____ Anthracite coal gives more energy than bituminous coal.
8. _____ Natural gas is not a fossil fuel.
9. _____ Coal is made from ocean sediment.
10. _____ Some land areas were once under water.

REACHING OUT Look back at figure C on page 165. Why are the water, oil, and gas found in layers?

HOW DO WE KNOW THE AGE OF FOSSILS AND ROCKS?

28



relative: compared with

absolute: actual, not compared with anything

radioactive: giving off special kinds of energy from the atom

AIM | How do we know the age of 28 | fossils and rocks?

How old is the earth? Scientists say about 4½ billion years old. We don't know that for sure. It is just an estimate—an educated guess.

The earth's age is estimated by dating its rocks. So far, the oldest rocks that have been found are about 4½ billion years old. How do we know the age of these rocks? We use special instruments and plain common sense.

Two kinds of dating are used—relative dating and absolute dating.

Relative dating does not give us an exact age. It just compares the ages of different things. In relative dating, you just say which is older and which is younger.

For example, you are older than a first-grader, but younger than your parents.

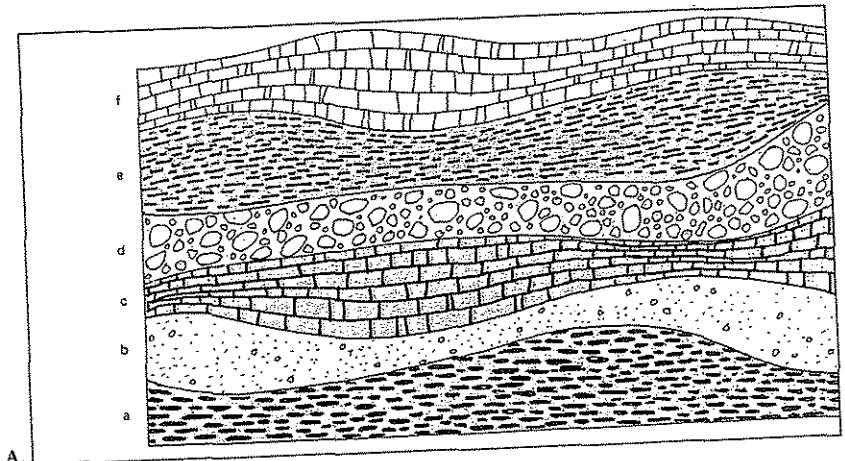
Absolute dating does give an age in actual number of years. For example: 3 years old, 1,000 years old, 2 million years old.

When we know the age of a rock, we know the age of the fossils in it. A fossil is the same age as the rock it is found in. And a rock is the same age as the fossil found in it. If we know one, we know the other.

UNDERSTANDING RELATIVE DATING

Relative dating uses a simple law of science. It says that younger rocks are found on top of older rocks.

The diagram below shows six rock layers. Study the layers. Then answer the questions below the diagram.



A.

- Which is the oldest layer? _____
- Which is the youngest layer? _____
- Which layer was laid down last? _____
- Which layer was laid down first? _____
- Name the layers in order in which they were laid down. _____
- Name the layers that are younger than layer d. _____
- Name the layers that are older than layer d. _____
- A fossil found in a rock layer is a) younger than b) older than c) the same age as the rock layer.
- A fossil found in e is a) younger than b) older than c) the same age as a fossil found in d.
- A fossil found in b is a) older than b) younger than c) the same age as a fossil found in d.
- This method of dating rocks and fossils is a) absolute dating b) relative dating.
- Relative dating _____ tell age in "number of years."
does, does not

DATING FOSSILS

Use the fossil key at the top of page 173 to answer the questions about the fossils shown below. Write your answers in the provided spaces.

FOSSIL KEY

NAME _____

NAME _____

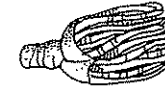
Trilobite



Starfish



Crinoid



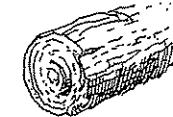
Dinosaur tooth



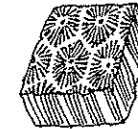
Snail shell



Petrified wood



Coral



Clam shell



- Name the oldest fossil in this picture. _____
- Name the youngest fossil. _____
- Name the fossils that are older than the coral fossil. _____
- Name the fossils that are younger than the coral fossil. _____
- Which fossil is about the same age as the snail? _____
- Which fossil is about the same age as the petrified wood? _____
- The ages given to these fossils are _____ ages.
relative, absolute
- Which fossil came from a land animal? _____

UNDERSTANDING ABSOLUTE DATING

There are several ways to find the absolute age of rocks and fossils. The most accurate way is the radioactive method.

This is how radioactive dating works:

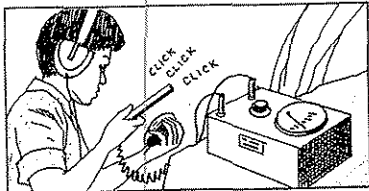
Certain elements are *radioactive*. This means that they slowly wear down. They change to simpler substances. Scientists know how long it takes for these elements to wear down.

Radioactive elements are found in many rocks and fossils. We find their ages by measuring how much these elements have worn down.

Most absolute dating is done by measuring radioactive carbon 14 and uranium 238.

Carbon 14 dates *fossils* of plants and animals that lived less than 50,000 years ago.

Uranium 238 dates rocks older than 50,000 years old.



This instrument is called a Geiger (GUY gur) counter. It measures radioactivity.

Answer these questions about absolute dating.

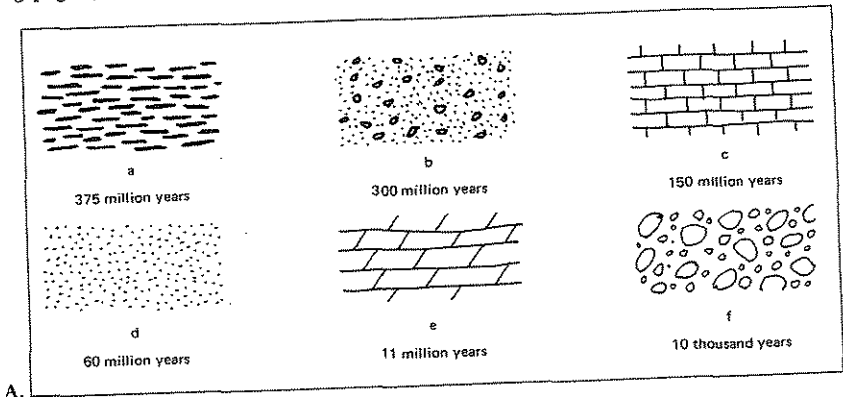
- Radioactive dating is a) relative dating, b) absolute dating.
- Radioactive dating _____ tell age in number of years.
does, does not
- Name two radioactive elements. _____, _____
- Which radioactive element dates rocks? _____
- Which radioactive element dates fossils of once-living things? _____
- Which radioactive element would you use to date the bones of an animal that lived less than 50,000 years ago? _____
- Which radioactive element would you use to date a rock millions of years old? _____
- Name the instrument that measures radioactivity. _____

DATE THE FOSSILS

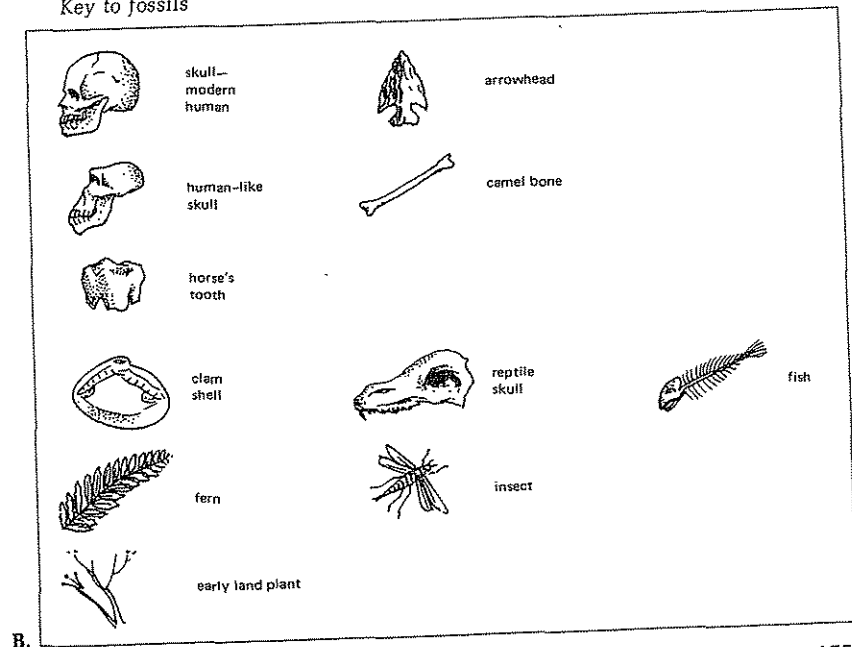
Rocks help us to date fossils. { Remember: A fossil is the same age as the rock it is found in.

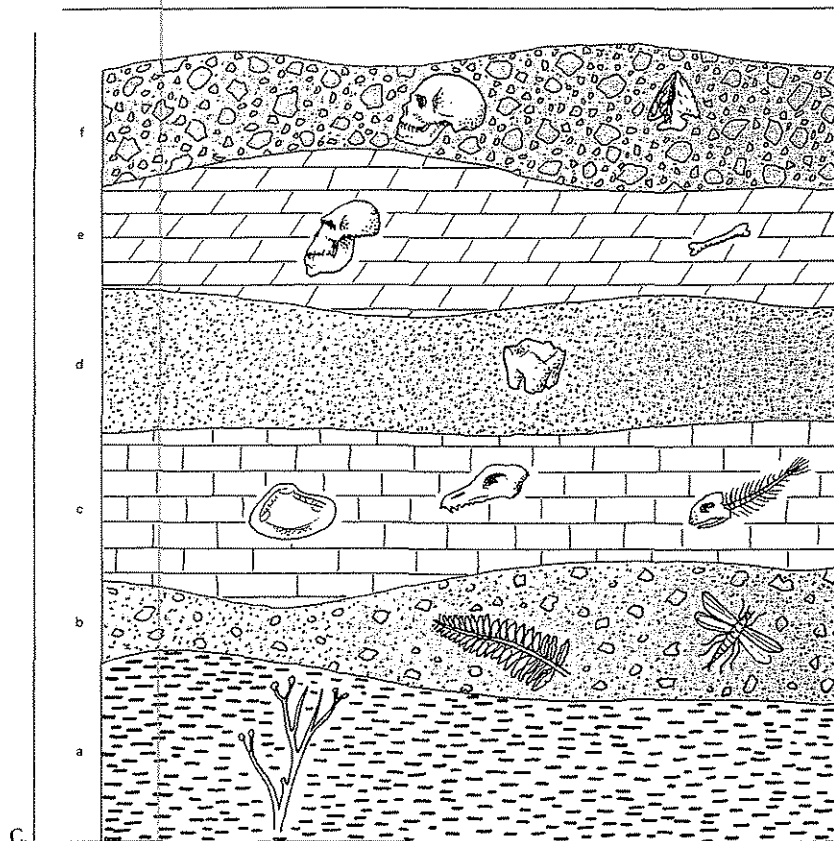
Date the fossils from the fossils found in the rocks.

Key to rock ages (This key will help you answer the questions on the following pages.)



Key to fossils





C.

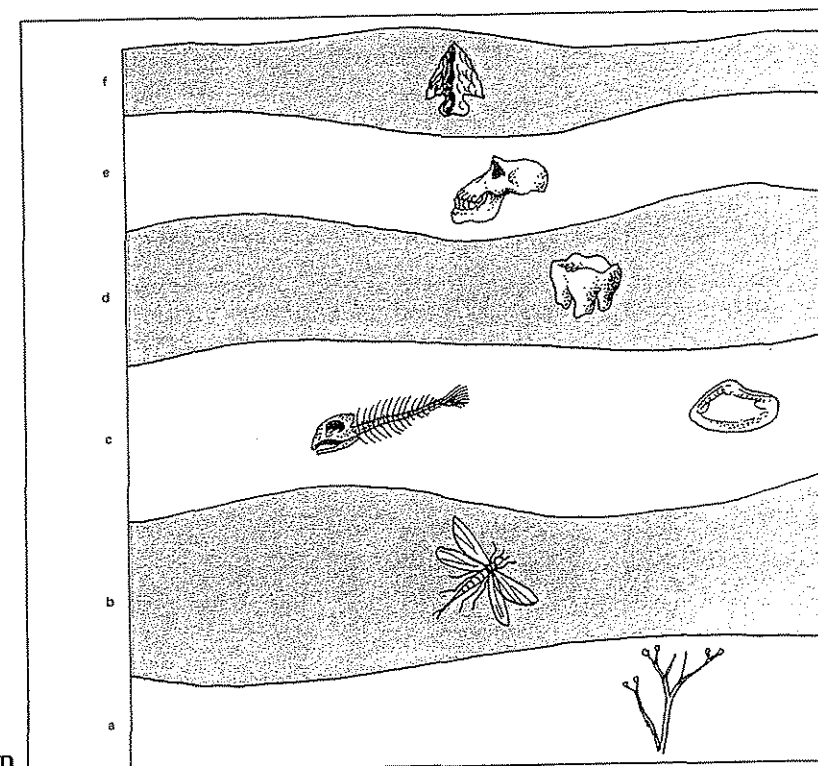
Fill in the ages of the following fossils.

Fossil	Age
1. fern	
2. skull of modern human	
3. early land plant	
4. horse's tooth	
5. camel bone	
6. reptile skull	

DATE THE ROCKS

See how fossils help to date rocks. Remember: A rock is the same age as a fossil found in the rock.

Use the ages of the fossils to date the rock layers in this diagram. You will have to check Figures A, B, and C on pages 175-176.



D.

Rock Layers	Age
1. b	
2. e	
3. c	
4. a	
5. f	
6. d	

COMPLETING SENTENCES

Complete the sentences with the choices below. Two of these may be used twice.

older
radioactive
does not
years old

the same
relative
younger

compares
actual
absolute

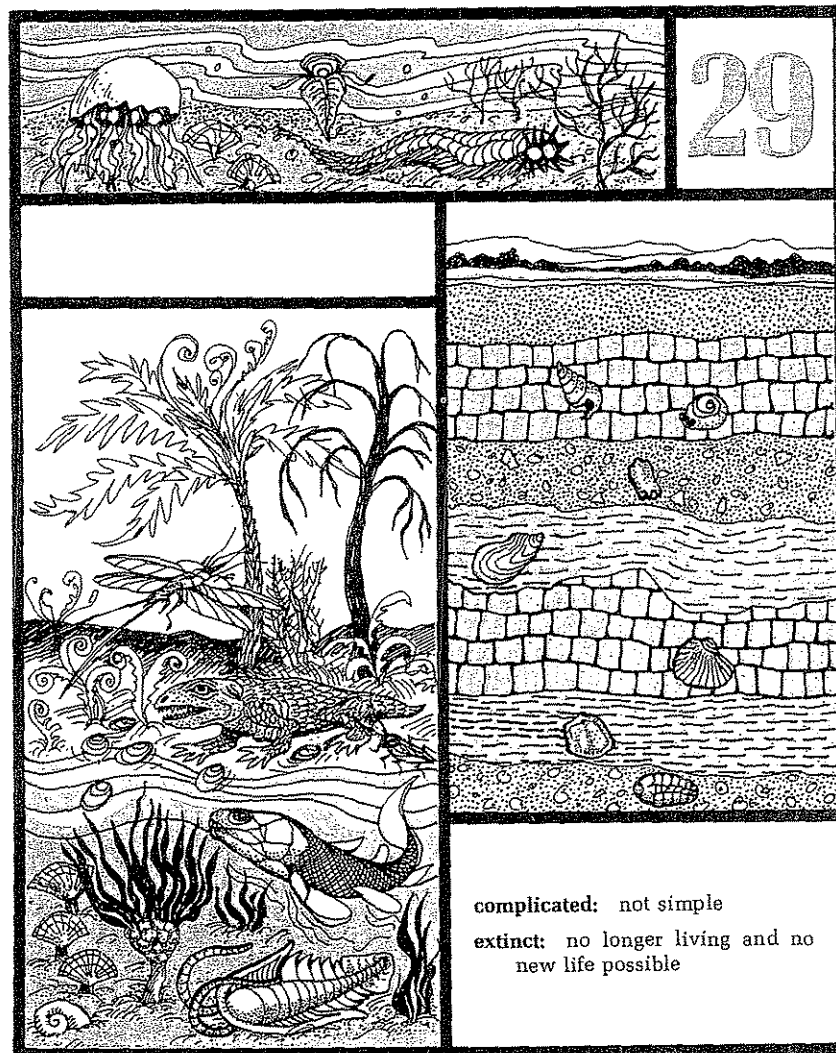
- The two methods of dating rocks and fossils are called _____ dating and _____ dating.
- Relative dating _____ tell actual age.
- Relative dating just _____ the ages of different rocks.
- Two words used in relative dating are _____ and _____.
- Absolute dating sets _____ age.
- The words used in absolute dating are "a certain number of _____."
- Most absolute dating uses _____ elements.
- The age of a fossil is _____ as the age of the rock in which it is found.
- Top rock layers are _____ than layers below them.
- Bottom rock layers are _____ than layers above them.

MATCHING

Match the two lists. Write the correct letter on the line next to each number.

- | | | |
|----------|-----------------|---|
| 1. _____ | relative dating | a) gives age in "number of years" |
| 2. _____ | absolute dating | b) dates dead plants and animals less than 50,000 years old |
| 3. _____ | uranium 238 | c) measures radioactivity |
| 4. _____ | carbon 14 | d) age is described as "younger or older than" |
| 5. _____ | Geiger counter | e) dates rocks older than 50,000 years old |

WHAT HAVE FOSSILS TOLD US ABOUT LIFE ON EARTH?



AIM | What have fossils told us 29 | about life on earth?

The detectives who have "read" the fossil clues have put together the story of life on earth.

Fossils tell us that there has been life on earth for nearly 3 billion years—maybe longer. The forms of life have changed greatly in that time.

Life probably began in the water. The earliest living things were simple plants and animals that lived in the sea. As time passed, more complicated forms of life appeared. Then some plants and animals left the water. They started to live on land.

Many plants and animals died out completely. They became extinct. The woolly mammoth, the trilobite (TRY luh bite), and the dinosaur are three extinct animals. There are fossils of about 130 thousand extinct plants and animals.

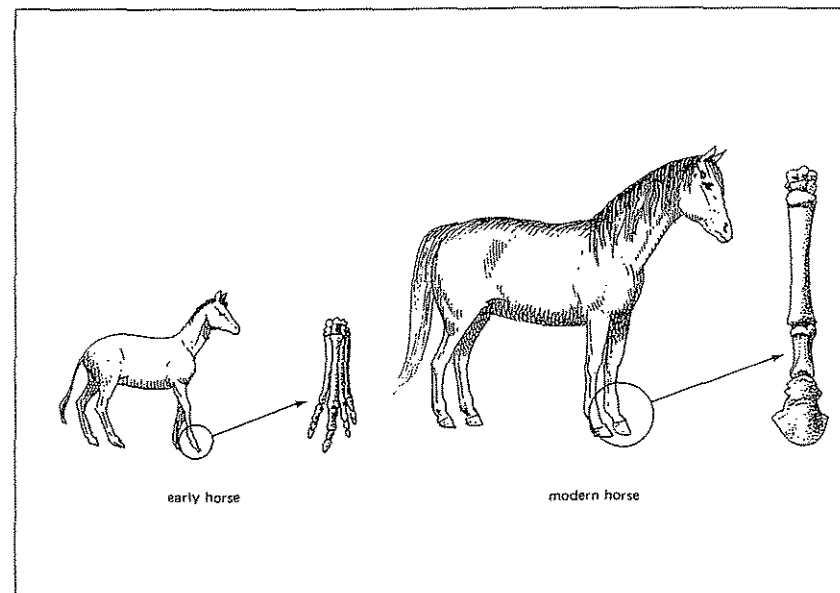
Some forms of life did not become extinct. They still live today. Animals like snails, snakes, and cockroaches can be traced from early times. They have hardly changed.

The fossil record is not complete. There are many gaps—empty spaces. But we now have a pretty clear story. We have been able to trace the development of most living plants and animals. And, what is most interesting for us, we have been able to trace the development of human beings.

When we study fossils, we are learning something about how the earth was formed. There are many theories about how the earth began. Some people believe that the world began as we are told in the Bible. Other people believe that the world developed naturally. Some believe that God caused these natural developments.

HOW THE HORSE DEVELOPED

Everyone knows what a horse looks like. The horse did not always look like it does today. The diagrams below show how the horse has changed. It took about 60,000,000 years for the horse to develop. Here's a surprise. The earliest horse was only about 61 centimeters (24 inches) tall.



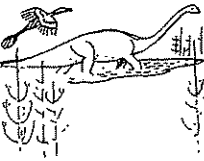
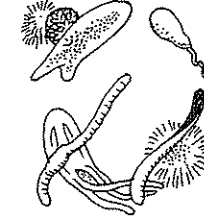
Study the diagrams. What changes do you see? Fill in the correct answers.

- I. 1. The horse _____ continued to grow in size.
has, has not
2. The legs have become _____.
shorter, longer
3. Side toes have been _____.
added, lost
- II. ■ A cow eats only plants. A cow's teeth are mostly flat.
- A tiger eats only meat. A tiger's teeth are mostly pointed.
- The teeth of a modern horse are mostly flat.
4. What do modern horses eat? _____

TIMETABLE OF LIFE ON EARTH

The chart below lists four eras of our planet. It tells about how long ago each one began and about how long it lasted. The chart also lists important kinds of life in each era.

Study the chart. Then answer the questions on the next page. (Read this chart from the bottom up.)

Era	Began About	Lasted About	Important Forms of Life	
Cenozoic recent life	60 million years ago	60 million years (to present)	Cattle, modern horse, apes and monkeys. Flowering plants spread.	
Mesozoic middle life	185 million years ago	125 million years	Huge dinosaurs rule the earth—then become extinct. First birds and mammals. First flowering plants.	
Paleozoic ancient life	550 million years ago	335 million years	Fish. First land animals (amphibians), and then early reptiles. Insects. Trilobites and many other sea animals with shells. Coal-forming period. Early land plants, then thick swamp forests.	
Proterozoic early life	1.7 billion years ago	1.2 billion years	Only simple sea life. Worms, jellyfish, sponges, one-celled plants and animals. There are hints of some very simple life dating back about 3 billion years.	

WHICH ERA?

I. Name the era . . .

- that was the oldest. _____
- that is the youngest. _____
- that lasted the longest. _____
- in which we live. _____
- during which dinosaurs lived. _____
- that had the simplest life. _____
- during which flowering plants first grew. _____
- that had many shell animals. _____
- that had many layers of thick forests. _____
- during which the first land animals lived. _____

II. In which era . . .

- did insects first appear? _____
- did early reptiles develop? _____
- was there only sea life? _____
- did coal form? _____
- did mammals first appear? _____
- did dinosaurs die out? _____
- did birds first develop? _____
- would you find King Kong? (if he were real) _____
- Take a guess; which era was very warm and moist? _____

COMPLETING SENTENCES

Complete the sentences with the choices below. Two of these words may be used twice.

land
snake
water
extinct

trilobite
3 billion
snail

changed
amphibian
dinosaur

- Life started on earth about _____ years ago.
- Life probably began in the _____.
- Some life that lived in the water started to live on _____.
- A frog can breathe in water or on land. A frog is an _____.
- A fish can live only in _____.
- People can live only on _____.
- Forms of life that have died out are said to be _____.
- Two examples of extinct animals are the _____ and the _____.
- Most organisms have _____ a lot over millions of years.
- Two animals that have not changed much are the _____ and the _____.

MATCHING

Match the two lists. Write the correct letter on the line next to each number.

- | | |
|--|----------------------------------|
| 1. _____ extinct | a) where life began |
| 2. _____ sedimentary rocks | b) not complete |
| 3. _____ in water | c) where most fossils are found |
| 4. _____ fossil record | d) earliest forms of life |
| 5. _____ one-celled plants and animals | e) dead and no new life possible |

TRUE OR FALSE Write T on the line next to the number if the sentence is true. Write F if the sentence is false.

- _____ Fossils are traces of past life.
- _____ Animals are the only kind of life.
- _____ There has been life on earth for billions of years.
- _____ Life began on land.
- _____ All organisms moved from the sea to land.
- _____ Early forms of life had only one cell.
- _____ As time passed, more complicated life developed.
- _____ Many kinds of plants and animals have changed a lot.
- _____ Snails and snakes have changed a lot.
- _____ Fossils help us understand how people developed.

WHICH CAME FIRST?

In each of the pairs below, one of the things came before the other. On the line next to each pair, write the name of the thing that came *before* the other. (To answer this, use the Timetable Chart, page 182.)

- one-celled animals or trilobites? _____
- frogs or jellyfish? _____
- frogs or birds? _____
- flowering plants or grass? _____
- people or dinosaurs? _____
- fossil or animal? _____
- cockroaches or birds? _____
- birds nonkeys? _____
- complicated life or simple life? _____
- one-celled organisms or many-celled animals? _____

WORD SEARCH The words in this list are hidden within the groups of letters.
Try to find each word. When you find it, draw a line around the word. The spelling may go backwards or forwards in any direction: up-and-down, across, or diagonally.

FOSSIL
REMAINS
MOLD
CAST
PRINT
AMBER
TAR
COLD
FUEL
COAL
DATING
EXTINCT

O	D	T	X	E	P	C	A	T
L	A	M	B	E	R	O	R	M
M	T	R	P	A	I	A	E	O
A	I	E	T	X	N	L	M	D
C	N	P	M	A	T	S	A	C
A	G	B	F	O	S	S	I	L
S	O	F	U	E	L	D	N	B
M	R	F	C	O	L	D	S	O
G	T	C	N	I	T	X	E	I